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THE
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OF

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THE
BOOK
OF
OBJECT LESSONS.
A TEACHER'S MANUAL.

COMPILED AND ADAPTED FOR USE IN SCHOOLS

BY
W. J. LAKE,
CERTIFIED MASTER OF THE CITY OF LONDON NATIONAL SCHOOLS,
ST. ANDREW'S, HOLBORN.

THIRD EDITION.

LONDON :
LONGMAN, BROWN GREEN, LONGMANS, & ROBERTS.

1858.

"Collective Lessons on common things now form a recognised and very important branch of education."—REV. F. C. COOK, H.M. Inspector of Schools: *Minutes of the Committee of Council on Education*, 1856-57, page 239.

"Another matter for remark is the importance of pressing upon Masters, Mistresses, and Pupil Teachers, the necessity of giving Lessons upon particular subjects to their scholars, whether simultaneously, collectively, or in class. Subjects should be studied beforehand for the purpose of giving Lessons upon them. In this way popular instruction may be given upon various topics, increasing the information and intelligence of the children."

REV. H. W. BELLARS, H.M. Inspector of Schools:
Minutes, &c. 1850-51.



LONDON:
Printed by SPOTTISWOODE & Co.
New-street Square.

P R E F A C E.

IN the following pages an attempt has been made to supply a want in educational literature, namely, a Manual containing "Notes of Information" on Common and Rare Substances, Animals, &c, so arranged that Teachers may readily select from it materials for oral lessons suited to the capacities of the respective classes of their schools. The last few years have given to the profession several able works by practical men upon the method of collective teaching, notes of lessons, and kindred subjects, but none, it is believed, supplying a series of outlines similar to the following. It is therefore hoped that this effort may obtain as favourable a reception as that awarded the lessons marked * when published in 1852 ; these have been entirely re-written, and greatly extended.

The scope and power of object teaching is almost limitless. It has been well observed —

“Precepts and rules are repulsive to a child, but happy illustration winneth him.

“In vain shalt thou preach of industry and prudence, till he learn of the bee and the ant.

“Dimly will he think of his soul, till the acorn and the chrysalis have taught him.

“He will fear God in thunder, and worship His loveliness in flowers ;

“And parables shall charm his heart.”

The use of objects, prints, diagrams, models, and specimens of raw and manufactured articles for illustration, is strongly recommended as most effective in conveying accurate impressions and ideas and fixing the interest and attention of the children under instruction. Dexter's Cabinets of Objects selected from the mineral, vegetable, and animal kingdoms are very admirable for this purpose ; they may be had at the various Educational Depositories. When these cannot be procured, the teacher will find he can soon form, with little trouble and expense, a collection for himself, probably somewhat limited, yet of the greatest utility.

The following extract from the Eighteenth Annual Report of the Metropolitan Church-Schoolmasters' Association refers to Lesson XLVII. of this

series, and explains the circumstances under which it was written:—"At the meeting of your Committee in March it was determined to offer a Prize for the best Notes of a Lesson on the History and Present State of the Woollen Manufacture in England. Messrs. McLeod and Daintree kindly undertook the office of adjudicators, and decided that the notes bearing the motto "*Acta non Verba*" were the best; this motto was found to have been adopted by Mr. W. J. Lake of the Second City School, who, according to the conditions, gave the lesson to a class of boys before the members at the General Meeting in October."

November, 1857.

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THE BOOK OF OBJECT LESSONS.

MINERAL KINGDOM.

LESSON I.—COPPER.

I. Description of Appearance, Qualities, &c.

NAME derived from Cyprus, whence the Greeks first obtained it. Latin name, *cuprum*. Colour, red ; lustrous ; malleable ; ductile ; a pound can be made to reach over a mile and a quarter ; very sonorous and tenacious ; lightest of metals except iron and tin ; good conductor of heat.

*II. Districts producing the Ore.**

Found extensively in the British Isles — mines situated in Anglesea (Amlwch), Cumberland, Staffordshire, Derbyshire, Devon, Cornwall (upwards of eighty ; produce, annually, some a hundred, others fifteen hundred tons), Ireland, Isle of Man ; Siberia ; Spain, Saxony, Russia, Sweden ; Morocco, Nigritia ; North America (Fahlun), Canada near the lakes Superior and Huron ; Brazil, Chili ; Cuba, Jamaica ; Australia (Burra-Burra), New Zealand.

* Every place mentioned in this and the succeeding lessons is to be found upon the map.

III. *Process of Preparation.*

Ore obtained by mining ; removed to the surface, and broken into small pieces ; “ best ore ” separated from the inferior ; crushed under large hammers or in mills or “ grinders ” (machines consisting of heavy revolving rollers) ; passed through sieves ; washed in large cisterns. Sold to the *smelters* ; smelting performed chiefly at *Swansea* ; fuel cheap and accessible ; ready means of export and plentiful supply of a valuable return cargo for vessels bringing the ore. Smelting consists of about *ten* different processes. The metal produced in various forms — ingots, slabs, sheets, &c. Devon and Cornwall export the ore to South Wales. Copper is exported from Swansea, London, Liverpool, &c.

IV. *Uses to which the Metal is applied.*

Copper ranks in utility next to iron ; enters largely into our manufactures at Birmingham, Sheffield, and Bristol.

Notice a few of its more common uses.

1. In household utensils — coppersmiths’ goods ; require to be kept very clean ; verdigris injurious to man.

2. For coinage ; copper coins of small value.

3. In making pins ; brass wire.

4. Copper-plates for engraving. Notice the pleasure and enjoyment derived from beautiful prints.

5. Sheathing, fastenings and cables for ships.

6. Boilers for locomotive and other engines ; vats, &c.

7. Useful alloys — *brass* (copper and zinc), *bronze* and *bell-metal* (copper and tin), *pinch-beck* and *tombac* (brass and copper).

V. *Statistics.*

The Swansea district contains nearly six hundred furnaces ; consuming five hundred thousand tons of coal per annum ; employing four thousand hands ; weekly wages amount to about four thousand pounds. Twenty tons of coal consumed in producing one of copper. Value per ton, from five to ten pounds.

LESSON II.—GOLD.

I. *Description of Appearance, Qualities, &c.*

A PRECIOUS metal ; yellow mineral ; very soft ; lustrous ; heavy ; exceedingly malleable. (Illustrations :—a grain can be beaten out to cover fifty-six square inches, or two and three quarter miles, of silver wire ; the gold of a guinea would reach nine and a half miles if beaten to extreme thinness, or cover eight miles of wire.) A perfect metal ; tenacious ; a good conductor of heat ; insoluble in water ; found as an ore, alloyed with copper, silver, and iron ; also in alluvial soil, in scales, grains, lumps ; *e. g.*, a lump of twenty-six pounds' weight found in Siberia in 1826.

II. *Countries where found.*

Very widely diffused ; *e. g.*, in (a) Europe—Hungary, Lead Hills (Scotland), small quantities ; (b) Asia—Ural Mountains, Siberia, Sumatra, Borneo, Celebes ; (c) Australia—Ballarat, Bendigo, Mount Alexander, The Ovens ; (d) Africa—Mozambique, Zanguebar ; (e) America—Mexico,

California, Brazil, Peru, Chili. Procured also from rivers ; *e. g.*, Danube, Rhine, Rhone, Tagus, Garonne ; African streams in the neighbourhood of the *Gold Coast*,—

“ Where Afric’s sunny fountains
Roll down their golden sands.”

III. *How obtained.*

Mines generally situated in lofty mountains ; difficult to work. Metal separated from the ore by *amalgamation* ; broken ; reduced to powder ; mixed into a paste ; mercury added ; latter taken away by heat ; earthy matters washed away. In Hungary, ore roasted ; fused ; alloys skimmed off. Stream gold obtained by washing sand ; the gold left at the bottoms of the pans.

IV. *Uses to which applied.*

1. *Sterling Gold*. — Gold and copper mixed, hence its reddish tint (too soft when pure) ; eleven parts gold, one of copper ; used for coinage. Question out the particular coins made of this metal.

2. *Standard Gold*. — Mixed with silver or copper ; these alloys affect its colour ; how ? Only two thirds of gold ; used by jewellers ; made into ornaments, rings, watch-cases, &c.

3. *Gold Wire*. — Manufactured into pins, chains, &c., by goldsmiths.

4. *Gold Leaf*. — Rolled very thin, then beaten between leaves of parchment, vellum, and gold-beaters’ skin (a beautiful thin membrane obtained from the intestines of the ox) ; varies in thickness from one two-hundred-thousandth to one three-hundred-thousandth of an inch ; used in gilding.

V. *Miscellaneous Notes.*

In the fifteenth century Columbus found the natives of Hispaniola wearing golden ornaments. In Brazil, when discovered, used by the natives for the commonest things ; as fish-hooks, &c., iron being unknown. One hundred and eight thousand four hundred and fifty-nine ounces (value about 3*l.* per oz.) received in seven weeks at Melbourne, from the Australian diggings in 1852. Sterling gold, stamped at Goldsmiths' Hall with a lion, a leopard's head (the Company's mark), a letter (for the year), the queen's head, the manufacturer's initials ; standard gold, the head of the sovereign, a crown, a letter, the initials of the maker, and a number to show its quality. Latin name, *aurum*; hence, aureate, auriferous, orange, &c.

LESSON III. — IRON.

I. *Description of its Appearance and Qualities.*

A most important metal ; heavy ; greyish white, with blue tints ; opaque ; malleable ; ductile, drawn into wire ; most tenacious ; fusible at great heat ; rusts when exposed to damp.

II. *Countries and Districts producing it.*

Very widely diffused ; found "in leaves, fruits, stalks, stems, and flowers, in the soil we tread, and in many minerals, in the flesh and blood of men and animals, even in milk and water." Native in small quantities. Mines most extensive in Great Britain, Norway, Sweden, Elba, Belgium, France, Prussia, Central Austria, Siberia, United States (the Alle-

ghanies). Russian iron superior ; immense quantities produced ; at Toula, found only a few inches below the surface of the sand. The Dannemora mine (Sweden) supplies Sheffield with about four thousand tons annually for the best steel.

III. (1) *Process of Manufacture* and (2) *Localities*.

1. Ore broken into small pieces about the size of eggs ; *roasted*—mixed with layers of small coal, kindled, and burnt for three or four days ; colour changed from grey to red or brown ; *smelted*—blast furnace (fifty to sixty feet high, open at top, closed at the bottom, air introduced by a blast-pipe) filled with ore, coke, and limestone ; metal becomes fluid ; sinks ; furnace tapped about every twelve hours ; run into furrows and channels of dry sand ; *cast-iron*, called also by the workmen *pig-iron*. Furnace constantly refilled ; not allowed to cool except for repairs. Rendered malleable, ductile, and tenacious by *puddling*—heated, stirred, beaten with forge hammers, drawn under heavy rollers ; called *wrought iron*.

2. Iron-works generally situated on or near *coal-fields* ; why ? — *e. g.*, in South Wales (Merthyr Tydvil) ; South Staffordshire, “the black country” (Wednesbury, Dudley, West Bromwich, Tipton) ; Shropshire (Colebrookdale, Iron-bridge) ; Yorkshire, North Derbyshire (Rotherham) ; Counties of Ayr, Falkirk, Lanark, and Stirling (Carron works, near the Firth of Forth). Recently discovered on Exmoor at Simon’s Bath. Till the end of the seventeenth century smelted in the *woody* districts ; charcoal was thought necessary. In 1619 a patent was taken out for *coal* fuel ; works were then situated in the Forest of Dean (Gloucestershire), the Weald (a wood), and generally in Surrey,

Sussex, and Kent, — as in Holt Forest, Woolmer Forest, St. Leonard's Forest, Tilgate Forest, &c.

IV. *Uses to which applied.*

Question out a few of its numerous uses. Of very great utility; cast into large pieces of machinery, wheels, cylinders, beams, posts, girders, pipes, tubes, &c.; wrought into many articles of ordinary use; "hardware;" household utensils — grates, stoves, locks, keys, bars, &c.; tools of husbandry — ploughs, harrows, spades, hoes, &c.; implements of war — guns, cannons, mortars, bombs, &c.; tools of the workshop — hammers, hatchets, nails, screws, &c.; iron-wire — fences, electric-telegraph wires, &c.; in architecture, &c. — iron churches, houses, bridges, ships, railways. Hardened into *steel* — "the welded steel, bright, blue, and sound;" made into "cutlery" — knives, razors, bayonets, swords, saws, scissors, files, chisels, axes, scythes; pens; steel-wire — needles.

Chalybeate springs — from Greek *chalups*, steel — contain a larger proportion of iron than other waters; used medicinally, externally and internally; common in Great Britain — *e. g.*, Tunbridge, Harrowgate, Holywell, Hartfell, Peterhead, Dumblane.

V. *Localities of Manufacture, Statistics, &c.*

Notice its importance in our manufactures; gives employment to upwards of three hundred thousand persons; numerous towns (among the largest and most populous) supported by it, towns

"Where labour bends

O'er thousand anvils;"

e. g., Birmingham, Sheffield, Dudley, Bromsgrove,

Wolverhampton, Walsall, Rotherham, Wrexham, Hawarden, Redditch (Worcestershire), in England; Rouen, Liége, Toul, Grätz, Pittsburg (Pennsylvania), abroad. English goods produced valued at seventeen millions sterling per annum. Hardware and cutlery are exported largely to the United States, West Indies, Hindostan, British America, and Australia,—iron and steel to Holland, France, and America.

LESSON IV.—LEAD.

I. *Description of Appearance, Qualities, &c.*

Soft bluish metal ; very malleable ; fusible ; when fresh cut, very brilliant ; not ductile (no wire made from lead). Black-lead so called from its colour.

II. *Localities producing the Ore.*

Very widely diffused. Mines in Cumberland, Westmoreland, Durham, Derbyshire, Cornwall, Devon, Somerset, Lancashire, Salop ; Flintshire, Denbigh, Merioneth, Montgomery ; Scotland — Dumfries, Lanark, Argyleshire ; Ireland — Wicklow, Clare, Wexford, Down, Armagh ; Spain, (Granada), France, Austria, Mexico, Peru, Paraguay, Chili. In North America, the Missouri mines the richest ; ore found in masses a few feet under the surface.

Black-lead found in Borrowdale (seven miles south-west of Keswick) ; in the coal-beds of Argyleshire.

III. *Process of Preparation.*

Ore called *galena* ; broken ; washed ; roasted in reverberatory furnace ; melted metal run into large pans ; ladled into cast-iron moulds ; now

pig-lead. A small quantity of silver generally found in the ore — from one to thirty ounces in a ton of lead. Rolled into sheets on tables. Lead-works very unhealthy; workmen suffer from colic, palsy, debility, &c.; cattle feeding in the neighbourhood are also affected.

England exports lead to France, Holland, Russia, India, Brazil, British America. Annual value, one hundred and eighty thousand pounds.

IV. *Uses.*

Draw from the children the uses to which it is applied, *e. g.* : —

1. Roofing for houses, churches, &c.
2. Cisterns, pipes, rain-gutters, &c.
3. Bullets and shot: molten lead mixed with arsenic, poured through a colander from a lofty tower or into a pit; forms globules, received into a vessel filled with water; dried on heated plates; sorted and packed. Bullets made in moulds.
4. Rusted and formed into pigments — red and white lead.
5. Enters into the manufacture of glass-paste — imitation of diamonds and other precious stones.
6. Black lead — *pencils* — placed in grooved cases of cedar.
- 7. Alloys: *type-metal* — four parts of lead, one of antimony; *pewter* — one fifth lead, four fifths tin; *solder* — equal parts of tin and lead.

LESSON V. — MERCURY.

I. *Appearance, Qualities, &c.*

- INTRODUCE the lesson by placing a small portion of quicksilver before the children, and elicit the

particulars by questions. A fluid; only metal found in that state; resembles water, oil, or melted silver—hence name, quicksilver. Becomes solid when exposed to intense cold (seventy-two degrees below zero); where would this occur?—is then malleable and ductile. One of the heaviest of metals—thirteen and a half times heavier than water. Boils at six hundred and sixty degrees—three times as great heat as required to boil water. Sometimes found pure, generally with ores, especially with sulphur (*i.e.* as cinnabar). Expanded by heat; compressed by cold.

II. *Localities whence procured.*

Found in many parts of the world; in small quantities. In Europe—Spain, Austria, borders of the Rhine, France, Sweden. In Asia—Japan, China, Ceylon. In America—Mexico. Principal European mines:—

1. *Almaden* in Spain, in Sierra Morena, sixteen miles north of Cordova.

2. *Idria* in Hungary, about twenty-five miles north-east of Trieste; eight hundred feet deep. Discovered by a peasant, soaking a new pail in a stream; filled it with sand; found it very heavy; carried some of its contents to the village priest; when examined, mercury found mixed with the sand. Afterwards mines were worked. They took fire in 1803; attempts made to smother the fire; the adjoining houses and buildings shattered as by an earthquake; ultimately subdued by introduction of water; works destroyed; three years before work re-commenced.

3. *Deuxponts* in Germany.

American mines discovered by the cinnabar used

by the Indians in painting their bodies ; destroyed —the pillars being removed, the roof fell in.

III. *Method of Preparation, &c.*

When pure, collected in *iron* jars ; obtained from cinnabar ; ore broken ; carefully picked ; reduced to powder ; mixed with lime in an *iron retort* (describe this vessel) ; strong heat applied ; sulphur and lime combine ; the quicksilver set free. A hundred-weight of ore produces about ten ounces of mercury. The produce of the Spanish mines conveyed on mules to Seville, in bags of sheepskins (each containing about fifty pounds), enclosed in two other similar coverings, and placed in barrels ; why ? The fumes very injurious ; miners afflicted with various diseases — palsy, blindness, fetid breath, paralysis, &c. ; the deleterious vapours raised by heat ; mines worked, therefore, chiefly in the winter season.

IV. *Uses.*

Used principally : —

1. In *refining gold and silver* by amalgamation. Imported into China, India, Peru, Mexico, and Chili ; why ? — exported from Spain.

2. In *gilding* : mercury and gold mixed applied to copper articles (*e. g.* gilt buttons) ; the former driven off by heat.

3. In *silvering looking-glasses* : tinfoil and mercury placed upon the plate ; pressure applied for several days ; the two adhere to the glass.

4. *Vermilion* for paint and colouring sealing-wax prepared from it.

5. In the manufacture of barometers and thermometers.

6. In *medicine* (*e. g.* calomel), a poison.

LESSON VI.—SALT.

EXAMINE a small quantity and elicit: —

I. *Appearance and Qualities.*

Color, white ; sparkling ; granulous or crystallised ; hard ; soluble ; sapid ; kinds—bay, common.

II. *Whence procured.*

1. The sea an immense storehouse of it ; the chief source. Notice its extent ; covers an expanse of one hundred and forty millions of square miles, and contains from two and a half to three per cent. of salt ; saltiness greater towards the tropics, less near the poles ; whence this difference ? From what does the saltiness proceed ? It has been supposed from vast beds of salt at the bottom, or from saline particles brought down by the rivers. Most probably a property given by God at the creation.

2. From the water of salt-springs, *e. g.*, those of Droitwich in Worcestershire.

3. From mines, rock salt, —*e. g.*, Northwich and Nantwich in the valley of the Weaver in Cheshire ; France, Hungary (Carpathian Mountains), Poland, Spain, Persia, Siberia. A salt *hill* in Catalonia, four hundred feet in height and three miles in circumference. In India, a whole *range of salt hills*. Salt *plains* in the Sahara and Abyssinia ; latter contains one of four days' journey in extent. Most remarkable mines :—That of Wielitckza ; of great depth ; a mile long ; half a mile broad ; contains houses, stables, streets, a church, statues, &c., cut out of solid salt. Those of Salzbouurg ; worked by admitting water, which, when saturated with salt, is pumped out, and the water evaporated by artificial heat.

III. *Process of Preparation.*

Water of the sea conducted into shallow "pans" or pits, *lined with clay*; why? Heat of the sun evaporates the water; salt left in crystals; operation repeated till a thick layer of salt is produced; removed for purification. Salt water of springs placed in pans over furnaces; water evaporated by artificial heat; solid masses of salt left; bullocks' blood stirred in brings away impurities. Rock-salt; the impure dissolved in water; consolidated again by heat. Bay-salt is largely procured from sea water by the Spaniards and Portuguese, especially at Setubal.

IV. *Uses.*

a. Used in food for men and cattle; highly beneficial to health; assists in the assimilation of our food — (best for culinary purposes, that obtained from the sea). Twenty pounds consumed by each person in England annually; in France, fifteen pounds. Cattle in Canada return at frequent intervals to the farms for it; when supplied, retire to the woods and pasture-grounds again. The fine wool of the Spanish sheep attributed to the quantity of salt they eat.

b. Preserves the ocean from putrefaction and corruption.

c. Increases its density; large bodies enabled to float upon its surface; *e.g.*, vessels traversing the Black Sea carry smaller cargoes than when passing through the Mediterranean; why? the former is sixteen times less salt than the latter.

d. Preserves food, especially for long voyages.

e. In medicine — *e.g.*, *Epsom salt* or *sulphate of magnesia*. "There are some saline springs in which sulphate of magnesia is a leading ingredient,

as those of Seidlitz, Seydschutz, Egra, and formerly those of Epsom in Surrey — whence the name of *Epsom salt*."

f. In manufactures — bleaching, glazing earthenware, hardening steel.

g. For manure, mixed with soot, in England, China, India.

V. *Interesting Facts bearing on the Subject.*

The Africans make long journeys from the interior to the coasts to procure it ; much relished by their children, as much as sugar by European children. A man's wealth measured by the quantity of salt he consumes ; "he eats salt," implies a rich person. Houses in Arabia anciently built of slabs of salt, cemented by sprinkling the edges with water. Its importance may be traced from the proverb, "Sole et sale nihil sanctius et utilius," — "Nothing is holier or more useful than the sun and salt."

VI. *References in Scripture.*

Frequently mentioned in the Bible ; notice a few places ; *e.g.* : —

1. "With all thy offerings thou shalt offer salt." — *Lev. ii. 13.*

"Every sacrifice shall be salted with salt." — *St. Mark, ix. 49.*

2. "Seasoned with salt" — symbol of wisdom. — *Col. iv. 6.*

3. "Sowed with salt" — emblem of sterility. — *Judges, ix. 45.*

4. "We are salted with the salt of the palace" (*marg. read.*) — denotes hospitality. — *Ezra, iv. 14.* Is thus regarded by the Arabs now.

5. "Ye are the salt of the earth." — *St. Matthew, v. 13.* "Ye are appointed by the holy doctrine which ye are to preach, and by the savour of

your good conversation, to purge the world from the corruption in which it lies.”—*Dr. Whitby*.

6. “The salt sea.”—*Gen. xiv. 3*. Its waters contain 24 per cent. of salt.

LESSON VII.—SILVER.

I. *Description of Qualities, Appearance, &c.*

WHITEST of all metals ; brilliant ; free from smell and taste ; soft ; easily scratched ; sonorous ; when mixed with alloys, malleable — *e. g.*, beaten into leaves $\frac{1}{10000}$ of an inch thick. Highly ductile — *e. g.*, drawn into wire thinner than human hair. Less tenacious than copper ; fusible ; about half as heavy as gold ; a *perfect* metal, loses no part when exposed to heat ; emits a green flame when burnt ; found native in lumps, in ores (especially with lead), and in crystals ; not in streams.

II. *Countries whence it is obtained.*

Found in many countries : *e. g.*, in—

1. *Europe*.—In the copper mines of Cornwall, lead mines of Cumberland ; Sweden, Norway, (Kongsberg), Upper Saxony, Hungary, Bohemia, Spain, Russia.

2. *Asia*.—Siberia, Chili, Japan, Birman Empire.

3. *America*.—Brazil, Colombia, Paraguay, Bolivia, Chili, Mexico, Peru. Principal mines in the *Potosi mountain* — conical shaped, four thousand feet high, perforated in every direction ; ore *dendritic*, resembles the branches of a tree in form. The silver produced conveyed from the mines by means of the llama ; thirty thousand so employed. Discovered by accident ; a shepherd tearing up a shrub found a mass of silver at its root.

III. *Preparation, &c.*

Obtained by mining ; separated from the ores by *amalgamation*. Standard silver consists, in twelve parts, of eleven and one tenth silver, and nine tenths copper. Hardest produced by the mixture being one fifth copper.

IV. *Uses to which applied.*

Employed in many ways, but tarnishes when exposed to bad air. (a) For *coins* (enumerate a few, both English and foreign); (b) *plate* — spoons, basins, flagons, cups, trays, tea-pots, &c.; (c) *ornaments* — baskets, ink-stands, &c.; (d) in the manufacture of indelible marking-ink and hair-dyes; (e) for *plating*; many articles have the appearance of silver; not of it, only plated; a plate of thin silver and another of mixed metal firmly soldered together; rolled into sheets; stamped, punched, hammered, and turned into the required shape, the silver being the outer and visible covering; done chiefly at Sheffield — hence called “Sheffield-plate;” at Birmingham — *electro-plating*; a model prepared of various substances (not metallic); immersed in a chemical solution of silver; galvanic battery applied; in a few minutes the silver is separated and deposited in an exquisitely fine, thin film over the whole design.

V. *Miscellaneous Notes.*

A grain may be drawn out four hundred feet. In 1478, a mass of native metal, forty-four thousand pounds' weight, was discovered in Saxony. American mines yield annually upwards of seven millions sterling of this metal. Latin name, *Argentum* — hence Argentine Republic, argent, &c. Rio de la Plata also means the River of Silver. La

Plata was supposed by the Spaniards to be very rich in it.

VI. *Scriptural References.*

Frequently mentioned in the Sacred Writings, and in very early times ; *e.g.* :—

1. *Silver* enumerated among Abraham's riches.
2. Silver was as plenteous as stones in Jerusalem during Solomon's reign.
3. Pieces of silver presented by Joseph to Benjamin.
4. "Thirty pieces of silver," the price received by Judas for the betrayal ; valued at 3*l.* 10*s.* 8*d.* (*Vide Ex. xxi. 32.*)

LESSON VIII.—TIN.

I. *Description of Appearance, Qualities, &c.*

BRIGHT shining surface ; lightest of common metals ; malleable ; not sufficiently tenacious to be drawn into wire ; most fusible of all metals except quicksilver ; found in primary rocks ; one of the oldest metals ; not pure or native.

II. *Localities producing it.*

In Europe—Devonshire and Cornwall ; Germany, Upper Saxony, Bohemia. Asia—Indian Archipelago, Malay Peninsula, Borneo, Banca (S. E. of Sumatra). America—Mexico, Chili.

III. *Manner of Preparation.*

Found as an ore ; two kinds, (1) stream and (2) mine.

1. Stream: superior ; called grain tin ; ore pounded and washed ; placed in blast furnace ; liquefied ; run into a kettle filled with wet charcoal ; the impu-

rities rise, and are skimmed off. The tin removed by a ladle, to form blocks; peculiarly brilliant.

2. Mine: ore brought to the surface; broken into lumps of small size; reduced to powder by a stamping mill (heavy beams cased in iron, raised by machinery); washed; sifted; thus separated from foreign substances. Pounded ore melted; liquid tin runs into iron kettles; formed into plates.

IV. *Uses.*

Employed in the manufacture of many articles in common use; *e. g.*:—

a. A coating for iron; cooking vessels of iron liable to suffer from acids, fat, air, water; therefore *tinned* (liquid tin placed in, and the vessel revolved; a thin film adheres to the surface).

b. Pins of brass wire whitened by boiling in tin.

c. Pewter, a mixture of tin and copper; employed for mugs, cups, formerly plates.

d. Tin-foil with mercury used in silvering looking-glasses.

e. Bell-metal, a mixture of copper and tin.

f. Bronze—beautiful statuary, ornaments, clocks, &c.

g. Tin-plate — (prepared thus: best bar iron rolled into plates, various thicknesses and dimensions; immersed in acid; scaled by exposure to heat; rubbed with sand; rendered smooth and uniform; dipped in a melted mass of tin and tallow); formed into kettles, saucepans, pots, mugs, &c.

V. *Historical Notice.*

One of the earliest articles of commerce with Britain—hence called “tin islands;” probably the Scilly Isles and Cornwall. Mines worked by the Romans; their wooden tools have been found in stream works; also a slab, with Roman inscription.

VEGETABLE KINGDOM.

LESSON IX. — CAOUTCHOUC.

I. *Description of Appearance, Qualities, &c.*

BLACK ; opaque (when pure, colourless and transparent) ; very elastic ; insoluble in water ; soluble in spirits of turpentine, naphtha, or ether ; inflammable ; of varied consistency ; some never becomes solid, but remains in a semi-fluid state ; tough ; impervious. Vegetable production ; the milky sap of a tree ; derived from two varieties, the Indian and the American.

II. *The Trees.*

1. The Indian — *Ficus elastica*. Handsome appearance ; erect trunk ; about six feet in circumference ; grows rapidly ; about the size of the English sycamore ; leaves, well-formed, smooth, bright green, and polished ; fibrous roots descend to the earth from the larger branches.

Many other Asiatic trees also yield the sap.

2. The American — *Siphonia elastica*. Called the “rubber tree ;” of great height ; perfectly straight trunk ; branchless except at the top ; leaves polished on both sides.

III. *Regions where found.*

Trees producing the gum are common in the East Indies, Southern China, Singapore, Mauritius, Madagascar, Java, Penang, &c. America — the banks of the Amazon and its tributaries ; Para and its vicinity very noted.

IV. *Gathering of the Sap.*

Trees incised horizontally; round the trunk and branches; at distances of about a foot; process repeated about every fortnight; juice more plentiful in warm weather; little obtained between October and March; received into cups or shells fastened to the trees, or collected in layers over clay moulds; each layer dried; redipped; when of the required thickness, placed in water, and the clay removed. Imported in the form of bottles, tablets, balls, and cylinders; occasionally formed into various ornaments, figures of animals, &c.

V. *Preparation of the Raw Material.*

First purified; cut with large, sharp knives, and thrown into hot water; torn by rollers and washed; kneaded in a strong cylinder enclosing a powerful revolving axis; changed to a light brown colour; pressed into moulds; cut into sheets by means of a swiftly moving knife.

VI. *Uses.*

Draw from the children that it is employed in the manufacture of many useful articles; *e. g.*:—

a. Over-shoes: chiefly made in America, at Newhaven, Connecticut. Raw material, from India, Africa, and South America (best from Para), softened and cleansed; rolled out by steam machinery; stamped; cut into proper shape. Two to three hundred tons used annually. Covered with waterproof varnish; baked in an oven at a heat of two hundred and eighty degrees. Sixteen hundred pairs completed daily. Exported largely to England and continental Europe.

b. Water-proof fabrics : general name macintosh. Caoutchouc dissolved in naphtha; worked into a paste; coloured as required; fixed to cloth by pressure; renders it air and water-tight; applied to silk, alpaca, &c., in the same manner. Clothes, water-beds, pontoons, &c.

c. Elastic articles : glove fastenings, braces, bracelets, bands, &c.; thin threads cut and covered with cotton or silk. A pound of the finest threads contains five thousands yards.

d. Springs, &c. Kneaded with sulphur; is not affected by change of temperature; called vulcanised.

e. Rubber : for removing pencil marks from paper.

f. Torches : formed into flambeaux by the Indians in Guiana; emits a strong unpleasant odour while burning.

LESSON X. — COCOA AND CHOCOLATE.

INTRODUCE the lesson by requiring the children to name the beverages commonly used at breakfast; dwell upon those which form the subject of the lesson. Produce a print of the plant, and draw out the particulars.

I. *Description of Plant and Fruit.*

The Cacao; distinguish from the cocoa-nut palm; reaches the height of sixteen feet; straight, slender trunk; branches begin about six feet from the ground. Flowers, fruits, leaves on the tree all the year round; evergreen. Flowers, scentless; reddish; grow in clusters directly from the wood of the

stem and larger branches, as in the black currant. Fruit, shape of a cucumber ; green ; brown when ripe, five inches long, covered with excrescences ; each fruit contains from thirty to a hundred seeds, about the size of almonds. Plants cultivated on plains ; by sides of rivers ; requires very damp soil, and to be sheltered from the sun, often protected by the coral-tree, hence called by the Spaniards *Madre del cacao*, "the mother of the cocoa." Propagated by seeds. Fruit appears in three years ; bears on an average thirty years.

II. *Regions where produced.*

A native of South America ; grows wild in Brazil and West Indian Islands ; cultivated in West Indies, Africa, Asia, the Eastern Archipelago. Grown in conservatories in England.

III. *Gathering.*

Fruit ripe when the seeds rattle inside on being shaken ; gathered by hand twice a year, in June and December. The produce of a tree is from two to three pounds, when carefully cleansed and dried. Sometimes, in South America, placed for a time under ground, to improve the flavour.

IV. *Preparation and Results.*

The seeds—"cocoa-nibs" or beans—crushed by large rollers on slabs of marble, kept hot by a fire underneath. Manufactured into chocolate and cocoa ; produces also an oil.

a. Chocolate.—Bruised nibs mixed with Cinnamon, honey, &c. ; worked into a paste ; pressed into iron moulds.

b. Cocoa.—Berries, less bruised ; often adul-

terated by the addition of sago, arrowroot, starch, lead, lard, red-ochre, &c. Sold in packets under various names, as soluble, homœopathic, &c.

c. "*Cocoa-butter*."—A vegetable oil extracted by pressure; white; solid; never rancid.

V. *Uses.*

1. Cocoa and chocolate: refreshing beverages; contain "theobromia;" very nutritious, more so than tea and coffee. Very cheap.

2. Oil: used in the manufacture of soap, candles, pomatum.

VI. *Introduction and Statistics.*

Was in use among the American Indians when visited by Columbus. Brought into Spain by the Spaniards from Mexico in the sixteenth century; thence carried into other parts of Europe; well known in England in the reign of Charles II. The seeds, sewn up in bags, were used by the ancient Mexicans as money (*cowries* are used similarly by the negroes of Africa). Three millions of pounds consumed annually in the United Kingdom.

LESSON XI. — THE COCOA-NUT PALM.

I. *Description of Fruit and Tree.*

PLACE before the children a specimen of the fruit in its natural state, and elicit the particulars. Brown-coloured nut; enclosed in thick triangular-shaped case of stout fibre; shell, hard and strong; compare kernel with that of common nuts; how

different?—encloses a refreshing liquid, cocoa-nut milk; marked with spots at one end,—holes filled with hard, thick substance; what does this end resemble?—hence name,—from Portuguese, *maccoco*, a monkey. Produced by a beautiful

Tree — “the Prince of Palms;” botanical name, *Cocos nucifera*; resembles a slender column; from sixty to a hundred feet in height; two feet in diameter; branchless:—

“The high palmetos lift their graceful shade.”

Marked with notches or rings; how caused? by the falling off of the leaves; *two* drop annually; these scars indicate its age; crowned with tuft of large leaves (some 14 ft., others 20 ft. long); look like immense plumes of ostrich feathers. Amid these hang the nuts, in clusters; from fifty to a hundred gathered from each tree.

II. (1) *Localities*, (2) *Propagation*, and (3) *Gathering*.

1. The most important product of the *tropics*; range of growth, fifteen degrees on each side of the equator; chiefly in Ceylon (ten millions growing there at a time); also in East and West Indies, Brazil, Sumatra, Guinea, South Sea Islands:

“Fanned by southern gale,
In some green isle of Indian seas;
Or did its graceful shadows sleep
O’er streams of Afric lone and deep?”

2. Propagated from the nut; ripe fruit selected; dried; exposed to the sun and air till leaves burst through the shell; planted; grows from the inside, *endogenous*; require names of other plants of the same class. Flourishes near the sea—on coral-reefs, islands, sand-banks. Groves of great beauty—“the foliage arching

forms long vistas, as it were, of a boundless Gothic edifice."

3. Tree bears fruit when twelve years old ; natives climb and gather the nuts. The Cingalese often train monkeys for this work.

III. *Uses of various Parts.*

These may be drawn out by brisk questioning. Uses almost innumerable ; affords food, clothing, shelter, &c., to the natives ; many useful articles to ourselves. To the Polynesians it

"Is clothing, meat and trencher, drink and pan,
Boat, cable, sail, and needle, all in one."

a. Trunk : building timber ; posts, drains gutters ; how adapted ? Imported into England as "porcupine-wood." Root, chewed by the natives ; very pungent.

b. Buds : as a vegetable ; delicate food ; good pickle ; called "cocoa-nut cabbage;" rarely used, because its removal causes the death of the tree.

c. Leaves : furnish grateful shelter while growing ; food for tame elephants in Ceylon ; thatch for huts ; sails for canoes ; formed into mats, carpets, baskets, lanterns, hats, bonnets, robes, books ; how written upon ? with a stylus ; the *midrib* used for oars and paddles.

d. Juice : extracted from the stem ; called *Toddy* by Europeans, *Sura* by natives ; when taken from the tree it is refreshing ; intoxicating when fermented : —

"From the palm to draw refreshing wine,
More bounteous far than all the frantic juice
Which Bacchus pours." — THOMSON.

“Arrack” — distilled from fermented toddy ; **Ja-gery** — sugar, obtained from it by evaporation.

e. Shells : made into drinking-vessels, vessels of measure (dry and liquid), cups, basins, ladles, &c.

f. Nuts : kernel, principal food of the poorer Indians ; oil expressed, “cocoa-nut oil” (distinguish from palm oil) ; supplies light ; exported ; nearly three thousand tons imported into England annually valued at 100,000*l.* ; milk, a cool, refreshing drink : —

“ Give me to drain the cocoa’s milky bowl.”

g. Husk : “coir ;” supplies a curling fibrous material resembling horse-hair ; manufactured into ropes, cord, string, mats, carpets, brushes, brooms, cushions, netting, bags (for expressing liquids from pulped substances), stuffing for mattresses : —

“ Spun from the fibrous nut, by art, is spread
Whatever clothes hearth, threshold, floor, and bed.”

IV. *Lessons.*

Lead the children to notice the wisdom and providence of God as displayed : —

(1) In giving the inhabitants of these hot, and in some instances nearly waterless countries, a tree yielding food and *drink*.

(2) Its hard shell adapts it for floating ; thus conveyed to distant islands, planting itself on their shores ; also for exportation, preserving the kernel during long voyages. (*Note.* Many cost nothing for freight, used as wedges to set fast the casks, &c., in cargoes of vessels ; hence its cheapness in England).

“Its (*i. e.* the cocoa-nut palm’s) very aspect is imposing. Asserting its supremacy by an erect and noble bearing, it may be said to compare with

other trees as man with the inferior animals. The blessings it confers are incalculable. Year after year the islander reposes beneath its shade, both eating and drinking of its fruit; he thatches his hut with its boughs, and weaves them into baskets to carry his food; he cools himself with a fan plaited from the leaflets; sometimes he clothes himself with the cloth-like substance which wraps round the base of the stalks; the larger nuts, thinned and polished, furnish him with a beautiful goblet; the smaller ones with bowls for his pipes; the dry husks kindle his fires; their fibres are twisted into fishing-lines and cords for his canoes; he heals his wounds with balsam compounded from the juice of the nut; and with the oil extracted from its meat embalms the bodies of the dead. He impels his canoe through the water with a paddle of the wood, and goes to battle with clubs and spears of the same hard material." — *Melville's Omoo*.

LESSON XII. — COFFEE.

A PRINT of the plant, a few berries, raw and roasted, and a little powdered coffee, will serve to introduce the lesson.

I. Description of the Tree and its Produce.

The *tree*: straight trunk; height, fifteen feet, kept down by pruning to about five feet; why? more convenient for gathering; branches, slender and drooping; light evergreen leaves, broad, smooth, glossy, similar to those of the bay-tree; flowers, white and fragrant (the Arabian jasmine); continue on the tree only two days; suc-

ceeded by berries ; red or purple when ripe ; each contains, two oval seeds, beans, or berries. Botanical name, *Coffea Arabica*.

II. Localities of Plantations.

A native of Abyssinia : (a) *cultivated* in Asia, Africa, and America ; (b) *imported* into Europe.

a. In Asiatic Turkey, Java, Ceylon, Manilla, Arabia, India; Mozambique ; West Indian Islands, Brazil, Central America.

b. From Ceylon, Java, Mocha (exports six thousand tons annually), New Granada, Venezuela, Ecuador, Brazil, Jamaica, Cuba, S. Domingo (or Hayti), Porto Rico, Chili. England *re-exports* it to Holland, Belgium, Austria, and Italy.

The colour of the berry varies, — *e. g.*, Mocha, dark yellow ; Java and India, paler ; Ceylon and West Indies, of a bluish hue.

III. Propagation, Gathering, Preparation, &c.

Propagated by seeds and young plants; plantations situated upon the sides of gently sloping hills; shade and moisture requisite ; when exposed to the sun sheltered by larger trees ; seeds set from five to ten feet apart ; bears fruit in the second year ; produce of a tree, from one and a half to three pounds of seeds. Harvest commences in May ; two or three crops in the year ; the first and the smallest berries of the best flavour. Picked or shaken from trees ; *pulped* (the outer membrane broken off by wooden rollers) ; dried ; winnowed ; why ? — broken berries, dirt, leaves, &c. removed ; seeds packed for the market ; exported. *Roasted* in close revolving (why ?) cylindrical vessels ; increased to nearly double their former

size, but lose one third of their weight ; cooled by tossing into the air ; ground for use.

IV. *Uses.*

In a raw state used medicinally ; has a sweetish taste. A pleasant beverage ; stimulating property called *caffeine* ; excellent drink for residents in fenny districts and damp places ; an antidote to vegetable poisons, as tobacco, laudanum, opium, &c. Caffaic acid, extracted from decayed berries, produces a bright green colour. Powdered coffee generally adulterated with burnt bread, rye, wheat, and *chicory* — roots of endive (a species of dandelion), cut into small pieces and roasted ; on the continent used by the poor as a substitute for coffee ; largely cultivated in Belgium, Germany, Channel Isles, and England ; its presence easily detected ; a spoonful of the mixture dropped into a glass of water ; the chicory sinks, staining the water a deep red.

V. *History and Statistics.*

The properties of the berry first discovered by a Mahometan doctor about the middle of the fifteenth century, who had observed the natives drink a decoction of the bruised berries ; — on his return from his travels, he took some as a medicine, found it removed headache, enlivened the spirits, and prevented sleep. Other accounts say, the prior of a monastery, seeing the wild goats become very lively and frisky after browsing upon the coffee plants, administered a decoction of the berries to his monks, to keep them awake during their vigils. Its introduction into Arabia, Turkey, Syria, greatly opposed ; *now* supplies the Turks and Ma-

hometans generally with a substitute for wine; why? First sold in Paris and London about 1650. In the reign of the second Charles, a license required for its sale. "Coffee-houses" suppressed in 1675; now very common; several hundred in the metropolis alone, as it may be sold when and where people choose. Fifty millions of pounds consumed annually.

LESSON XIII. — CORK.

I. *Description of Appearance, Qualities, &c.*

LIGHT; very buoyant, specific gravity only one fourth that of water; dry; soft; compressible; elastic; appears very porous, not so in reality, the pores not communicating with each other. Bark of a tree —

"The cork tree's furrow'd rind."

II. *Localities of Cultivation, &c.*

Native of the warmer regions of the temperate zones. Cultivated in Italy, Spain, Southern France, Algeria, &c., in forests and parks (unknown in the New World). Grown occasionally in England as a curiosity. Species of oak; botanical name, *Quercus suber*; evergreen; principal forest-tree where oaks are wanting; sometimes, therefore, the "king of the forest."

III. *Preparation of the Bark.*

Stripped from the tree when fifteen years old; tree allowed eight years to recover; process then

repeated; a tree bears this operation ten or eleven times; bark improves as the age of the tree increases. Procured in long strips, in thickness some two or three inches; slit vertically and horizontally at the top and bottom of the trunk; removed with a peculiarly shaped knife; sometimes, after incised, left to shed itself. Soaked in water; dried and partly scorched; hence black appearance of the outside; this renders it more imporous — heat closes the pores; flattened under heavy weights while heated; packed in bales; exported; five hundred tons imported into England annually.

IV. *Uses.*

Applications varied, important, and numerous, both among ourselves and foreign nations; *e. g.* :—

1. *Corks.* — Liquids formerly kept in casks and jars stopped with clay, pitch, plaster of Paris, and similar substances; afterwards drawn into bottles, the necks stopped with pieces of bark — “corks;” first used in the seventeenth century; made by cork-cutters in most cities and towns of the kingdom; cut into slips; cleverly rounded with a sharp knife.

2. *In the construction of life-boats, &c.* — Floats of cork used by fishermen in very ancient times, as by the Romans. Much cork used in a life-boat — the gunwales (edges) lined on both sides to the depth of two feet, and the seats filled with it; thus rendered extremely buoyant. Employed in making life-belts, cloaks, capes, and jackets, designed to save from drowning.

3. *In the manufacture of hats.* — Cut into thin veneers for the foundation of hats; very light. Veneers extremely thin; some have been printed upon instead of paper.

4. *In making models.*—A material excellent for imitating ruins, decayed walls, &c.; models of towns, castles, cathedrals, churches, abbeys, remarkable ruins, made of it; very beautiful and valuable.

5. *For soles of boots and shoes, &c.*—Good preservative from damp; affords comfortable protection to the feet; used in this manner by the Chinese as well as by ourselves. Burnt cork made into Spanish black. Also useful for artificial limbs, cork legs, arms, &c.

6. *In Kamptulicon.*—A compound of cork and caoutchouc; a good sheeting for ships of war; its great elasticity causes the balls to rebound.

7. *Foreign uses.*—By the Spaniards and Portuguese very extensively applied to numerous useful purposes: *e. g.*, made into bee-hives, baskets, plates, cups, tubs, and other domestic utensils; a substitute for slates and tiles in covering roofs; lining for damp walls.

LESSON XIV.—THE COTTON PLANT.

EXHIBIT a cotton-pod, pieces of manufactured goods, and a print of the plant. Question out the particulars.

I. *Appearance of the Plant.*

Belongs to the same class as our hollyhock and mallow; ten or twelve different species; chiefly three cultivated.

1. The *herbaceous*: most important; an annual; two feet high; foliage, dark green, in shape like the sycamore; flower, pale yellow with purple centre;

followed by three-celled capsule or pod, about the size of a walnut ; each cell filled with a white, soft, downy, fibrous stuff, and a number of small seeds (like grape seeds) ; this white or buff mass is *raw cotton*.

2. The *shrubby* : biennial or perennial, according to climate ; reaches the height of twelve feet.

3. The *arborescent* : largest twenty feet high ; not much cultivated ; produce least valuable.

II. *Regions where cultivated.*

Grows naturally in Asia, Africa, and the New World. Cultivated in the Birman Empire, India, China ; Egypt, Central Africa (about Lake Tchad, the Niger, and Senegal) ; United States (North Carolina, South Carolina, Louisiana, Ohio, Alabama), Mexico, West Indies, Colombia, Brazil ; the southern countries of Europe to a very small extent. *Sea Islands* cotton the finest ; produced near Charlestown (North America), on sandy plains near the coast. *Upland* or *bowed* cotton grown inland. America chiefly supplies Lancashire ; why ?

III. *Method of Propagation, Gathering, &c.*

Propagated by seeds on sandy soils ; sown along ridges five feet apart ; often blighted by frosts or cold winds ; attacked by the "cut-worm," which eats off the tender plant ; thinned of all weak ones ; repeatedly hoed and weeded ; in autumn caterpillars destroy whole plantations—*e.g.*, a field of four hundred acres ruined by them in a few days. The cotton-fields present a very beautiful appearance. When ripe, the capsules burst ; harvest about six months after the plant-

ing ; generally in August ; cotton and seeds drawn out of the pod by the gatherers (men, women, children) ; placed in bags suspended from their necks ; removed into baskets. Gathered in the morning and in dry weather only, because discoloured by exposure to the sun's rays ; dried on wooden platforms for a short time ; the wind and sun injurious to it. Harvest continues for several weeks during August, September, October, and November. Prepared for exportation by "whipping ;" leaves, husks, dirt removed ; passed through the "gin" between cylinders, to separate the seeds from the fibre ; packed in bales into the smallest possible compass (why ?) by great pressure—*e. g.*, a bale occupying twelve feet will weigh as much as five hundred-weight.

IV. *Manufacture : (a) Results and (b) Localities.*

a. Raw cotton imported into European states (as at Liverpool, Greenock, Havre-de-Grace, Marseilles), and made up, by carding, spinning, and weaving, into warm, cheap, comfortable, agreeable clothing—*e. g.*, calico (named from Calicut on the Malabar coast), muslin (Mosul), velvet, velveteen, corduroy, fustian, nankeen (Nankin), prints, stockings, &c.

b. Manufacture located in England, in Lancashire ; upon a coal-field ; nearly one person in six of the whole population engaged in the trade. Manchester (about thirty miles from the coast on the Irwell) the "cotton metropolis ;" other surrounding towns also supported by it—*e. g.*, Preston, Bolton, Oldham, Blackburn, Wigan, Ashton-under-Lyne, Rochdale, Bury, Warrington, Burnley, Staley-Bridge, Chorley, Accrington, &c. In *Scotland*—Glasgow, Paisley ; *Ireland*—Tullamore (King's County). On the *Continent*—Paris,

Lyons, Rouen. In *America* — Lowell (Massachusetts), Cincinnati (Ohio), Springfield.

V. *Statistics, Historical Facts, &c.*

The goods produced partly consumed at home, partly exported to United States, East Indies, Brazil, Germany; cotton twist and yarn also to Belgium, United States, and Germany. Gives employment to seven hundred thousand persons in England alone; commodities produced valued at thirty millions sterling per annum. Manufactured in India a thousand years ago; comparatively a modern art in England, of little importance till the later half of the eighteenth century. Contrast the labour and machinery of the two countries now. Draw out how it is that we can undersell them, when an Indian spinner will work for three farthings a day. Present price of raw material from three-pence to eight-pence per pound; fifty years since it was eighteen pence.

"A song for the plant that brings money and fame,
Gave Ashton its being and Preston its name;
Whose ships fill the Mersey each flow of its tide,—
That is Manchester's riches and Liverpool's pride.
It peoples the waste, it encloses the fen,
'Tis the joy and the wealth of the Lancashire men;
It gives us our meat and it makes us our dress,—
So a song for the Cotton! we cannot do less."

NEALE.

LESSON XV.—GUTTA PERCHA.

A PORTION of the raw material, some manufactured article, and a print of the tree may be used to introduce and illustrate the lesson.

I. *Description of Appearance, Qualities, &c.*

Gutta, a gum or juice — percha (pronounced pertsha), the name of a tree ; other varieties, gutta-girek and gutta-tuban. Raw material : the gum ; white or dirty yellow colour ; when worked, becomes brown ; opaque ; flexible when heated ; impenetrable ; incorrodible ; tenacious when cold (*e. g.*, a cord one eighth of an inch thick ; will support a weight of forty-two pounds) ; very buoyant, twice as light as cork ; when softened, resembles caoutchouc ; becomes rigid as it cools.

II. *Description of the Tree.*

A forest tree — *Sapotacæ* ; yields a milky juice or sap ; grows to a considerable size ; three to six feet in diameter, sixty to seventy in height ; flourishes on alluvial soils, near the foot of hills ; wood, soft and fibrous, useless for timber.

III. *Locality of Production.*

Widely diffused throughout the Indian Archipelago : Borneo and adjacent islands ; the Malay peninsula. Chiefly exported from Singapore.

IV. *Gathering and Preparation.*

Tree pierced ; formerly cut down (why discontinued?) — the exuding juice received into a trough ; consolidates by exposure to the air ; formed into shapeless blocks ; exported. The many impurities contained in it must be removed ; first *sliced* — blocks pressed against a wheel armed with knives, thus cut into thin slices like chips of wood ; softened in hot water ; torn and divided into shreds ; impurities sink ; where is the gutta percha ? why

floating? Washed in cold water. Placed in cylinders with revolving axes — “*masticators* ;” thoroughly kneaded (being softened by steam) ; rolled into sheets.

V. *Results of the Manufacture.*

Its uses very varied ; made into a great variety of articles of utility and ornament — *e. g.*, tubes, pipes, whips, reins, balls, cord, clothes-lines, nets, speaking-trumpets, life-buoys, hats, capes, leggings, clogs, soles of boots and shoes, boxes, mouldings, picture-frames, embossed maps and globes for the use of the blind, cups, buckets, a covering for electric telegraph wires, ink-stands, pen-trays, baskets, watch-stands, vases ; wheel-bands in machinery, boats (extremely light ; weigh only eighteen pounds ; some were taken by the recent Arctic expeditions, and answered well).

VI. *Discovery and Introduction.*

Discovered in the Malay Islands by Mr. Lobb the botanist. Dr. W. Montgomery introduced it into England in 1843 ; a specimen presented to the Society of Arts — manufactured into a pipe, a band, and a bottle-case. The manufacture is rapidly increasing — *e. g.*, in 1844, two hundred and thirty pounds were imported — in 1848, one million seven hundred thousand.

LESSON XVI. — MAIZE.

I. *Description of Plant.*

STEM, strong ; reedy ; knotted ; rises from eight to ten feet — occasionally attains fourteen feet.

Leaves, long ; broad ; yellow ; a great number spring from the top of each stem. Corn, the seeds, or grains, in large, thick, yellow ears. Several varieties ; the European only six feet high ; leaves narrower ; pendent tops.

II. *Localities where cultivated.*

Native of America ; sometimes found wild. Cultivated very extensively in the West Indies. One of the chief commercial products of Mexico, United States, Canada, Paraguay ; grown also in Europe — Spain, Portugal, Lombardy, and France.

III. *Propagation, Cultivation, &c.*

Grain generally sown in May. Requires a fertile soil ; seeds placed in the ground two or three feet apart ; carefully watered and thinned. Ears plucked off the stalks ; gathered into baskets ; conveyed into barns. Stalks gathered after a time, tied in bundles, and stored. Ears housed in casks, bins, &c. ; shelled into tubs, across the tops of which are placed blunt swords, or pieces of iron hoops ; each ear scraped over this till all the grains are removed. Machinery is sometimes substituted for this tedious manual labour. A man will shell twenty-five bushels daily. Grain now ready for the mill, but will keep uninjured for from five to six years. Generally yields excellent crops ; where carefully watered by artificial irrigation, four hundred bushels have been gathered for one sown. Less subject to disease than wheat ; not beaten down by storms or affected by mildew or blight, though attacked by insects and birds. In Mexico, as many as three crops taken annually.

IV. *Uses.*

Prepared in various ways; affords nourishment to man and other animals. More nutritious than wheaten flour. Every part useful; *e. g.*:—

1. *Indian meal*.—Principal food in the United States; chief support of the Mexicans; largely consumed in Africa. Exported from New York, New Orleans, and Baltimore, under the name of Indian meal. Supplies food to the greatest number of people next to rice.

2. *Leaves*.—Serve as forage for cattle; they require soaking in water; pigs, horses, and poultry very fond of them. When dried, used as stuffing for mattresses; furnish cool elastic beds.

3. *Ears*.—When young and tender, roasted and eaten with butter and salt, very delicious food; when riper, boiled in their leaves and eaten.

4. *Stalks*.—Spirit expressed.

5. *Husks*.—Manufactured into writing paper in Italy; in America used for stuffing beds.

LESSON XVII.—THE OAK.

I. *Description of Appearance, &c.*

EXHIBIT a print of the tree, and question out the particulars. Tree of great beauty; of various heights and sizes; very noble in appearance; “king of the forest,”—

“The builder oak, sole king of forests he.”

SPENSER.

Wood, tough; hard; durable; no insect can pierce its heart. Bark, strong.

"Its heart is like the iron wood,
Its bark like plated mail."—HOWITT.

Large spreading branches ; beautiful green foliage ; fruit, an acorn in a small cup. Tree, exogenous (require meaning and etymology). Lives three or four hundred years ; trunk marked by circular rings,—each shows a year's growth.

"For centuries grows the oak-tree,
Nor doth its verdure fail."—HOWITT.

Best age for felling, between fifty and seventy years ; oak-apples caused by an insect. Botanical name of the tree, *Quercus Robur*.

II. Localities where cultivated, &c.

Regions where found extend to sixty-three degrees N. lat. in Europe ; in Asia, to fifty-two degrees. Many species—two, natives of great Britain. Cultivated from acorns in extensive forests and plantations (many planted by birds and squirrels ; acorns buried by them for winter stores ; those forgotten spring up into trees). Common in Spain, France, Greece, Italy, Prussia, Ireland, Scotland and Canada. English Forests—New Forest, Epping, Sherwood, and Dean.

"On earth the forests' honour'd king,
Man's castle on the sea,
Who will of another tree may sing,
Old England's oak for me."—B. BARTON.

III. Uses to which applied.

Notice the numerous uses to which the several portions are applied ; *e. g.* :—

1. *Trunk*.—Timber, for shipbuilding (called "father of ships") ; four kinds chiefly used for this purpose,—Welsh, Sussex, Adriatic, and Baltic (last

two imported from Italy and Prussia). Why well adapted for this use? Used also for furniture, carvings in churches, roofs, floors, and fittings of public buildings; beautiful appearance when polished.

“ But prouder yet its glories shine,
When, in a nobler form
It floats upon the heaving brine,
And breasts the bursting storm.”

2. *Bark*.— Used in tanning; afterwards as fuel and manure.

3. *Saw-dust*— in dyeing ; gives a brown, drab, or fustian colour.

4. *Acorns*.—Food for swine, birds, and squirrels; formerly eaten by the inhabitants of this country ; at the present time made into bread in Asia Minor; peasantry in Spain eat a sweet species, which grows there.

5. *Oak-apples, or galls*.—Imported from warm climates; used in making ink.

IV. *Historical Notices.*

Many oaks connected with public events in English history; notice a few,—*e. g.* :—

a. Druids worshipped under its shade, as in the forests in the Isles of Man and Anglesea—mistletoe cut with golden sickles from it with great ceremony.

b. Oak in the New Forest, connected with the death of William Rufus.

c. Queen Elizabeth's at Huntingfield, Suffolk.

d. Damory's in Dorsetshire ; remarkable for its size — circumference sixty-eight feet, interior cavity sixteen feet ; used during the Commonwealth as an ale-house ; shattered in 1703.

e. Royal Oak, Boscobel ; escape of Charles II. ; notice 29th of May.

V. *Lessons.*

Draw from the children :—

1. The importance of firmness :—

“ Let your courage be stout when the Truth you defend ;
 Let its enemy break you before he can bend ;
 Stand firm to his bluster, stand fair to his stroke,
 If he is the tempest, then you be the oak.”— NEALE.

2. And of little things :—

“ Think how little was the acorn,
 Whence the mighty tree is made.

Little efforts work great actions ;
 Lessons in our childhood taught,
 Mould the spirit to that temper
 Whereby noblest deeds are wrought.
 Cherish then the gifts of childhood,
 Use them gently, guard them well ;
 For their future growth and greatness
 Who can measure, who can tell ?”

Moral Songs.

LESSON XVIII.— THE ORANGE.

I. *Description of (a) Fruit and (b) Tree.*

(a) *The fruit.*—Name derived from the Latin *aurum*, and French *or*, “gold;” shape spherical ; colour, bright yellow, *orange coloured* ; probably the origin of the “golden apples” of the ancients. Rind, strong ; lined with white ; filled with little bags of oil, which, by means of the small pores, keep the fruit fresh ; contrast this with the covering of plums, peaches, &c.—the orange better adapted for transport. Inside, pulpy ; divided into cells or cloves ; each subdivided into little juicy vessels ; why ? Compare with honey-comb ; in hot weather large quantities of honey ferment ; never

occurs in the comb, although the temperature of the hive may be very high ; prevented by the division into small cells, each containing but a little ; similar contrivance in this fruit ; hence it is capable of being kept longer. Produced by —

(b) *A tree* of great beauty ; straight stem ; rich, elegantly shaped, ever-green, polished leaves ; delicate white flowers—the “orange blossoms” so often admired by poets ; very sweet-scented—

“ The full-blossomed trees
Fill all the air with fragrance and with joy ; ”

from their beauty and sweetness, often given as bridal offerings in countries where they grow. Flowers succeeded by round, green fruit ; changes colour as it ripens ; a year reaching full maturity ; hence flowers and fruit are seen at the same time ; “its promise and performance are both visible together.”

II. Localities of production.

Native of China ; several varieties still cultivated there ; now grown in and near many tropical countries of both hemispheres ; in England under cover. Exported from the Canaries, Malta, Crete, Sardinia, Barbary, St. Michael's (a small island of the Azores, or Western Islands), South America, Spain and Portugal : —

“ Where Portugal and haughty Spain
Display their orange groves.”

Tangier supplies the fragrant little *Mandarin* (the Chinese make presents of it to their Mandarins ; even the rind may be eaten, and, when quite ripe, the pulp may be shaken like a ball within). Malta, the red-pulped or “blood orange,”

“Seville,” the bitter variety, and “St. Michael’s,” give names to others; the last is smaller, with a smooth rind and sugary pulp.

III. *Propagation, Cultivation, Gathering, &c.*

Grown in common with fruit of the same species—the citron, lemon, lime, shaddock—in groves:—

“Bear me, Pomona! to thy citron groves;
To where the lemon and the piercing lime,
With the deep orange glowing through the green,
Their lighter glories blend.”

Orangeries of various sizes; some contain a thousand trees:—

“Where hangs in shades the orange bright
Like golden lamps in a green night.

Propagated from the pips or seeds (may be raised in a flower-pot in a warm room); planted in rows; in the hottest countries shaded by hedges; is seven years reaching maturity; attains a great age; blossoms in March and April; fruit of the former year then thoroughly ripe; that exported gathered previously, when only partly ripened, in November and December; ripens on the passage; wrapped in maize-leaves; packed in chests of various sizes, containing from five hundred to a thousand. Packing is an interesting sight; children spread out the leaves, men wrap an orange in each; others place in the boxes, which, when filled, the carpenter covers with thin slips of wood; removed to the shore on asses’ backs. A hundred wholesale consists of a hundred and ten. Trees very prolific—one sometimes yields twenty-six thousand; in the Spanish peninsula the trees are smaller and the crops less.

IV. *Trade and Statistics.*

Three hundred millions imported into England annually ; sixty millions sold in London—fifteen millions in the streets only ; three thousand street-sellers in the metropolis. Contrast this present large supply and sale with that of the fourteenth century, when the purchase of “seven oranges” of a Spanish merchant by Queen Eleanor was thought worthy of record in her household book. Two thousand vessels are engaged, carrying two hundred thousand boxes, in the Azores’ trade.

Note.—“I never experienced the bewilderment, the intoxication, which accompanied my visit to the gardens of Milis. Here there is nothing but oranges—not, if you please, fruit placed at regular intervals along the branches and encompassed by verdure, but large clumps of thirty or forty oranges, dragging the branch which bears them towards the earth. Do not imagine a group of orange trees here and there,—the perfume of which comes and goes as you approach and leave it,—but try to realise the idea of a wood, a veritable forest ! As far as the eye can reach under this balmy forest it meets with nothing but oranges—oranges in the fore-ground, oranges in the half-distance, oranges gild the horizon ! The perfume of the blossoms intoxicates you. A gathering is a very simple process. A cloth is spread under a tree ; a man, having climbed the branches, precipitates the golden harvest to the ground, whence arises an indescribable aroma. Of the forty-eight hours at Milis I spent at least thirty in the orange woods, gathering a store of sweet perfume for less happy times, and envying Sardinia so great a treasure.”

LESSON XIX.—RICE.

I. *Appearance, &c.*

NOTICE the sources whence man obtains food—the animal and vegetable kingdoms ; question out a few products of the latter, and lead the children to think of the subject of the lesson. Let them describe it as sold in this country. Small white grains ; brittle ; opaque ; very absorbent ; pulverable ; contains much starch, eighty-five parts in every hundred. The produce of a plant something like barley ; grains grow each on a separate stalk, springing from one stem ; crowned with an *awn* or *beard*.

II. *Localities of Production.*

Native of Asia ; extensively cultivated in both worlds ; *e. g.* :—

1. *Asia*.—China (middle and southern parts), Arabia, Ceylon, India (especially Bengal ; why ?), Japan, Persia, Sumatra, &c.

2. *Africa*.—Egypt, Madagascar.

3. *Europe*.—Italy (Lombardy, Piedmont—the northern limit), and Spain.

4. *America*.—Southern States, North and South Carolina, Georgia, Alabama, Virginia ; South America, West Indies.

Many varieties ; generally known by the name of the districts producing them—*e. g.*, Patna, Madagascar, East Indian, and Carolina. *Cargo-rice*, very inferior ; imported as *ballast*. Relate the circumstances of its introduction to America ; “ a ship returning from India was cast upon the shores of Carolina, some bags of rice being found among its stores, a trial was made of sowing it.” The experiment proved successful beyond expectation.

III. *Cultivation, Harvest, and Preparation.*

Humid soil best ; low plains traversed by large rivers well adapted ; mean temperature required, seventy-four degrees. Methods of cultivation vary ; among the Chinese, the seed is soaked in manured water ; sown after the heavy rains upon the fields inundated by the rivers—what effect is produced by these floods upon the land ? The young plants appear in about two days ; when grown to the height of six or seven inches, they are pulled up, tops cut off, roots washed, and replanted in rows about twelve inches apart. In America and Europe a system of artificial irrigation is adopted ; grain sown in March in trenches ; plantation inundated till the seeds sprout ; water drawn off, and the ground allowed to dry ; in about a month (the plants being three inches high) the grounds are again flooded, to destroy the weeds, &c. ; in July, for the third time, the operation is repeated, and the rice ripens standing in the water. Great ravages are made upon the green corn by the rice-bird. Reaped with a sickle having a saw-like edge ; bound into bundles ; removed ; grain trodden out by cattle or beaten in mortars. First crop harvested in May and June, the second in October and November. The gathering is both disagreeable and unhealthy on account of the exhalations arising from the damp, muddy soil. The outer husks removed from the grain by a mill, the inner separated by means of large pestles and mortars ; screened to remove the broken grain ; packed in casks ; exported or stored for home consumption.

IV. *Uses.*

Very nutritious food ; chief sustenance of many

millions among the Asiatic nations—in China and India eaten at all meals. The staple food of the native tribes in India and negro population of America. Highly esteemed by the Chinese; when informed that Britain produced no rice, they regarded its inhabitants as objects of pity, and expressed surprise that they could possibly exist without it. Notice that its dryness prevents fermentation, and adapts it for food in hot climates. Compare it with wheat and barley—both less fitted for this purpose. Wine obtained by fermentation from it. In England made into puddings, bread, blanc-mange, &c. Used in the manufacture of starch.

LESSON XX. — SUGAR.

I. *Appearance, Qualities, &c.*

COMPOSED of small crystals; fusible; combustible; emits a bluish flame; sweet taste; soluble (question out other substances possessing the same quality—salt, glue, soap, gum, &c.; and contrast with insoluble substances—sand, glass, stone, sponge); imported into England; manufactured; *natural* sugar, *honey*. Of great importance: “We consume it in millions of tons; we employ thousands of ships in transporting it; millions of men spend their lives in cultivating the plant from which it is extracted; and the fiscal duty imposed upon it adds largely to the revenue of every established government.” Sold under various forms—*e. g.*, raw or moist, and loaf.

II. *Substances from which it is extracted.*

Notice its abundance; sources very varied; found in carrots, turnips, potatoes figs, dates,

maize, &c. ; separated from only a few substances; why? Sugar of commerce derived chiefly from three sources — *the sugar-cane, beet-root, and sugar-maple*. The cane: a species of *grass* plant; attains the height of seven feet, occasionally twenty; bright yellow colour, streaked with red; dark green top; long, narrow, serrated, leaves hang from the reed; jointed stem, each joint furnished with a bud, the germ of a new plant. The appearance of beet-root may be questioned out, also that of the maple.

III. *Localities of Plantations, &c.*

Region most favourable to the cultivation of the cane, the torrid zone; it ranges in America thirty degrees on each side of the equator, in the Old World to about thirty-five or thirty-six degrees. Native of India; cultivated also in America and West Indies (introduced by the Spaniards at S. Domingo), China, Brazil, Cape Verd Islands, Mauritius, Bourbon, Bengal, Siam, Java; formerly in Europe, still to a small extent in Valencia and Granada.

Beet-root.—Europe—France, Belgium, Germany, Prussia, Russia.

Maple. — Forests of British America — Canada, New Brunswick; United States (New Hampshire, Vermont, New York, Michigan).

IV. *Propagation and Gathering of the Cane.*

Propagated by means of cuttings; shoots of about three feet in length planted in trenches, three or four feet apart, during the autumn. Stems shoot from the joints of the planted pieces. Reach maturity in from ten to twenty months. Plan-

tation presents a beautiful sight when grown up and in blossom ; “a field of canes standing in the month of November, when it is in arrow or full blossom, is one of the most beautiful productions that the pen or pencil can possibly describe. The cane commonly rises from three to eight feet or more in height ; it is, when ripe, of a bright and golden yellow, and, where exposed to the sun, is in many parts very beautifully streaked with red ; the top is of a darkish green, but as it becomes more dry, it is of a russet yellow, with long narrow leaves depending, from the centre of which shoots up an arrow like a silver wand, from two to six feet in height, the summit having a plume of white feathers, delicately fringed with lilac.”

V. *Process of Extraction.*

1. *From the cane.*—When ripe, cut off *near the root* ; why ? Tops removed ; cut into lengths ; tied into bundles ; removed in carts to the *mill* ; passed between three heavy rollers — cast-iron cylinders revolving in contrary directions ; the thick, gummy, grey-coloured juice gradually expressed ; received into a cistern ; refined by the removal of the colouring matter ; exposed to heat ; boiled with *lime-water* ; why ? Cooled in shallow pans ; granulates ; placed in wooden boxes with perforated bottoms ; *molasses* drain off ; exported in casks or hogsheads ; raw or muscovado sugar. Further refined after importation :—dissolved in water ; blood or lime-water added ; poured into conical moulds ; drained and baked ; produces *loaf sugar*. Clayed sugar :—colouring matter removed by means of *clay* ; the moisture of the clay, filtering through, carries away the uncrystallised portion ; each loaf separated into three distinct

parts—the base white, the middle yellow, the small part brown.

2. *From beet-root.*—Roots ground to a pulp between toothed rollers; juice expressed; the residue resembles a dry cake; juice boiled; lime mixed; cooled and drained. Another method:—roots sliced; sugar washed out in hot water; the solution boiled, &c.

3. *From the maple.*—Gathered in March, April, and May; trees incised; sap collected; boiled; crystallises; poured into oblong moulds; “two or three men will make from three to five thousand pounds in a season of two months.”

VI. *Uses.*

Extensively used for food:—sweetening tea, coffee, &c.; preserving fruits, meat, &c.; very nutritious in its original state; the cane chewed and sucked (sold for this purpose in American markets, — *e. g.*, at Manilla, Rio Janeiro, Orleans, &c.). Average annual consumption in England, twenty-eight pounds a person. The cane serves as fuel and manure; the green tops also as food for cattle. Rum extracted from the molasses.

Note.—Quantity produced annually amounts to four thousand five hundred and twenty-seven *tons* from the cane, twenty millions of *pounds* from beet, and forty-five million *pounds* from the maple.

LESSON XXI. — THE TEA PLANT.

I. *Appearance and Propagation.*

AN evergreen shrub; botanical name, *Camellia Bohea* — species of camellia. Height, from three

to six feet ; dark green leaves ; white flowers, similar to those of the dog-rose ; soft, green berries or pods, each containing two or three seeds. Propagated by seeds—on light, strong ground, sides of hills, or banks of rivers ; requires an abundance of light and air ; sown five or six in a hole, in rows four or five feet asunder. Yields first crop when three years old.

II. *Localities where cultivated.*

A native of China and Japan ; cultivated between the thirtieth and fortieth degrees of north latitude—district called “the tea country ;” further north too cold, south too hot. Common in English conservatories—*e. g.*, Kew Gardens. Would grow in Europe ; manual labour being dear, would increase the present price, even allowing the cost of carriage by sea and land from Asia.

III. (1) *Gathering and* (2) *Preparation.*

1. The *leaves*, not the fruit, the crop ; gathered three times a year, in spring, summer, and autumn ; occasionally a fourth harvest. Spring leaves of most delicate colour and best flavour ; autumn produce very coarse and inferior ; crops decrease in value as the age of the plant increases ; hence trees cut down when about ten years old, and new shrubs spring from the roots. Collectors trained to the business ; gather the leaves one by one, wearing gloves ; why ? For the same reason they are required to abstain from eating fish, and to bathe daily several times ; if expert, a man can gather twelve pounds in a day.

2. *Preparation.*—Placed in shallow baskets and exposed to the sun and air for some hours, —rids them of dampness ; removed to flat iron

drying pans, fixed over stoves, heated by means of charcoal fires, in drying houses; about a pound operated upon at once; stirred with a brush; again placed in baskets; curled or rolled up by rubbing in the hand; again dried; picked, spread on a table, examined, and imperfect leaves removed. The finest tea, *e. g.*, gunpowder, rolled leaf by leaf. Assumes the crisp, shrivelled appearance it exhibits in our shops. Packed in chests lined with tin-foil; exported.

IV. *Uses.*

Tea, an infusion of the leaves, a common beverage; exhilarating, refreshing, and stimulating; contains "theine;" peculiarly adapted for people taking much vegetable food; assists in its assimilation, *i. e.* increases the bile.

"The bubbling and loud hissing urn
Throws up a steamy column, and the cups
That cheer but not inebriate wait on each."

Taken by the Chinese without sugar or milk; sold among them and the Japanese in public places, like ale in England.

V. *Historical and Statistical Notices.*

Brought into Europe by the East India Company, in the seventeenth century; from Holland to England in 1660, by Lords Arlington and Ossory; duty charged upon every gallon of liquor sold, one shilling and sixpence. Regular importation commenced in 1669; then sold for sixty shillings a pound. In 1664, a present of two pounds two ounces made to Charles II. by the East India Company. Present importation amounts to fifty millions of pounds annually,

valued at two millions one hundred thousand pounds sterling. Various names; over a hundred among the Chinese:—*e.g.*, *Black*—Souchong, Pekoe, Bohea, Congou; *Green*—Singlo, Hyson, Gunpowder. When first introduced, was frequently cooked and served up as a vegetable; its proper use then unknown.

LESSON XXII.—TOBACCO.

I. *Description of Qualities, Appearance, &c.*

POSSESSES a strong unpleasant odour; bitter, nauseous taste; brownish colour. A vegetable product; *leaves* of a plant. Name probably derived from *Tabac* in S. Domingo (whence first imported into Europe), or from the *tabac*, the instrument used by the Indians in smoking it; called also *Nicotia*, from Nicot, the French ambassador, who brought it from Portugal into Paris; hence our adjective *nicotian*.

II. *The Plant.*

A large branching herb; many different species; the two principal, *Virginian* and *Green* tobacco—the former the larger and finer plant. Stem, from three to six feet in height. Large leaves, about two feet long, of pale green colour, covered with small hairs; bears pretty pink flowers, but these are removed to perfect the leaves.

III. *Localities of Production.*

A native of America; very anciently grown in China; now cultivated over a large portion of the globe.

a. In Europe. — Raised in many countries — Hungary, Germany, France, Holland, Spain, Belgium. Chief manufactory at Seville.

b. In Asia. — Turkey, Persia, India, China, Java, Philippine Islands, Ceylon, Australia, and New Zealand.

c. In Africa. — Egypt, Algeria, the Canaries, Cape of Good Hope, and districts of the interior.

d. In America. — Produced most extensively in the United States; also in Canada, New Brunswick, Mexico, Brazil; Cuba, and other West Indian Islands. Best from Cuba.

The market price of the various kinds differs, that of Cuba being eighteen-pence, and of Canada only four-pence a pound. Best in Asia, from *Latakia* (Laodicea) and *Manilla* in the Philippines.

IV. *Propagation, Cultivation, and Gathering.*

An annual; grown in fields or plantations; land prepared in March and April; seed sown mixed with lettuce or mustard seed; these plants serve as protection from the fly; how? Generally planted near a river; in a light soil. Leaves change to a yellowish-brown colour as they ripen and harvest approaches. In August, plants cut down with sharp knives; stems split; exposed to the sun upon the hills; dried; gathered into bundles; packed in cases for exportation.

V. *Manufacture: the Process and Results.*

Principally manufactured into three articles — (1) tobacco, (2) cigars, and (3) snuff.

1. *Tobacco* is sold under various names, and in different forms. The leaves roughly broken called *kanaster*, from *canastra*, a basket, in which it is exported: — *shag*, the midribs of the leaves removed;

pressed and cut into shreds :— *bird's eye*, similar to shag, but contains the midrib :— *twist*, moistened with treacle; beaten till soft ; twisted into a kind of rope or cord ; called also *pig-tail* and *roll*. Largely adulterated with sugar, gum, cabbages, salt, saltpetre, peat, yellow ochre, &c.

2. *Cigars*. — Made from the dry leaves without their midribs ; sprinkled with saltpetre; why ? Rolled into a cylindrical form ; covered with fine leaves free from thick fibres ; hence Dutch tobacco leaves exported to Cuba and North America for that purpose.

3. *Snuff*. — Leaves fermented ; powdered ; moistened with salt and water ; packed in close tin cases. Sold in two forms, dry and moist.

More than five hundred manufacturers, and nearly a hundred and fifty thousand retail dealers, in the United Kingdom.

VI. *Uses.*

Used chiefly for three purposes — (a) chewing, (b) smoking, and (c) snuffing.

a. *Chewing*. — A filthy and disgusting habit — practised mostly in Europe among sailors, who have few opportunities of smoking ; very general in America, especially in the Southern and Western States.

b. *Smoking*. — This practice is very prevalent in England, also throughout Europe, China, India, and Turkey. Supposed to have been introduced into England by Sir Walter Raleigh (relate anecdote of his servant). Greatly opposed by both civil and ecclesiastical authorities. Most hurtful ; produces effects similar to opium and other narcotics, but in a less degree — nausea, paralysis and torpor, vomiting, weakness, loss of appetite and indigestion. Termed

by King James I. "a custom loathsome to the eye, hateful to the nose, harmful to the brain, and dangerous to the lungs." In England an average of nineteen ounces per person consumed annually of what is well called —

"Filtth of the mouth and fog of the mind:
Africa with all her foison
Boasts no more pernicious poison."

c. Snuffing.—A dirty habit, happily less common than formerly; prejudicial to health; destroys the sense of smell; changes the tone of the voice; impairs the digestion.

VII. *Lessons.*

Elicit from the children that it is our duty to avoid these practices; not in youth to contract habits which in after life we may in vain endeavour to break through. To resist them —

1. *On account of health*: as injurious to that which we are morally bound to preserve.

2. *As habits of self-indulgence*: contrary to the self-restraint and denial we are to observe.

3. *As useless expenditure*: waste of time and money; the expense of cigars, pipes, tobacco, &c., carefully applied, would supply many comforts and necessities in sickness and old age.

4. *As a social duty*: these habits most disagreeable to others, and to many an intolerable nuisance.

5. *As disreputable*: they neither confer the manliness nor independence which many young men suppose, but are indeed too often the signs of idle and dissipated lives.

ANIMAL KINGDOM.

LESSON XXIII.—THE BAT.

I. *Appearance, Structure, &c.*

RESEMBLES a quadruped *generally* (in its covering, internal structure, and being viviparous), but *in the air* a bird (possessing wings and the power of flight). Body covered with fur of a yellowish brown or grey colour. Forearms long; fingers longer; covered with skin (a soft, delicate membrane); has the power of extending this to form wings; the bones something like those of a man's hand; hence *cheiroptera*, from Greek *cheir*, a hand, and *ptera*, a wing—*hand-winged*. Thumb at end of each wing, with a hooked nail, used in hanging. Wings, the most acute organ of touch. Small eyes; large ears. Many varieties; upwards of two hundred have been enumerated; twenty species found in Great Britain—among others the common bat, the great bat, the serotine, mouse-coloured, long-eared, horse-shoe, &c.

II. *Regions where found.*

Most numerous in tropical countries. *Common* bat found in roofs of houses, church towers, caverns, hollow trees, and holes of rocks—in Great Britain and Continental countries;—*Vampire*, in South America, Chili, West Indies, New Caledonia, the Isle of Bourbon; Java.

III. *Food, Habits, &c.*

Food varies; some feed on insects, caterpillars,

&c. ; others on fruit ; others on raw, dressed, or tainted meat. Common bat often found in larders clinging to a joint of meat, sucking a good meal. Dormant during the day ; seen during the twilight of summer evenings flitting through the air.

“ What shall I call thee ? Bird, beast, or neither ? ”

“ Just what you will ; I’m rather both than either ;
Much like the season when I whirl my flight,
The dusk of evening, neither day nor night.”

Torpid in winter ; reposes suspended, head downwards, covered with its wings.

Vampire sucks human blood from any part of the body exposed during sleep ; six ounces lost by a man in one night, from sleeping with his foot uncovered ; attacks horses also. Bats of this country are harmless. May be tamed ; has been trained to take food from its master’s hand. Occasionally destroyed in great numbers—*e. g.*, during one night one hundred and eighty five were taken from the eaves of Queen’s College, Cambridge, and two hundred and eighty-six the next.

IV. *Uses.*

Draw from the children its use.

1. A great destroyer of insects ; eats large quantities ; the earth scarcely habitable without it.

2. Serves as food ; the vampire, when fat, eaten by Indians ; the *frugivorous* eaten in the Isle of Bourbon, Madagascar, and Java ; in flavour like a partridge.

3. Its hair used to ornament their war-clubs by the natives of New Caledonia.

V. *Adaptation of its Structure.*

a. Its acute sense of hearing and feeling protects it from danger in the pursuit of its prey.

b. Dormant when food is scarce; few insects to be had in winter.

c. Its wings suited for suspension : —

“ The bat that, with hook’d and leathery wings,
Clung to the cave-roof.”

LESSON XXIV.— THE BEAR.

I. *Description of Appearance and Structure.*

EXHIBIT a print of a bear, and elicit the particulars by interrogation. Quadruped; plantigrade (from Latin *planta*, “ a sole,” and *gradus*, “ a step”); they walk upon the *soles* of their feet. Compare with the tiger or cat; how do they walk? Heavy body; peculiar gait; very strong paws; five toes, armed with sharp claws. Omnivorous (require the etymology). Teeth resemble men’s. Size, from eight to ten feet long; one taken weighed one thousand six hundred pounds. Three chief kinds — (*a*) white or polar, (*b*) black, and (*c*) brown. Other varieties, the grizzly and Syrian.

II. *Regions and Countries where found.*

Inhabits every zone; formerly a native of Great Britain.

a. *White* found in Polar regions; sometimes seen floating on the icebergs in the Atlantic Ocean : —

“ Where the shivering huntsmen tear
Their fur coats from the grim white bear.”

b. *Black*, in America; a smaller species in India.

c. *Brown*, in Asia, Russia, Sweden, and forests of Central Europe.

III. *Disposition, Habits, Food, &c.*

Surly; solitary and capricious; very ferocious; nocturnal; extremely sagacious. Powerful swimmer; can swim a distance of eighteen or twenty miles. Lives in caves or hollow trees. Torpid during winter:—

“The shapeless bear,
With dangling ice all horrid, stalks forlorn;
Slow-paced and sourer as the storms increase,
He makes his bed beneath the inclement drift.”

Re-appears in spring—hungry and wild, “bony and gaunt, and grim;” attacks any living thing coming in its way; suffocates its enemies by embracing them with its strong fore-paws. May, however, be overcome:—*e. g.*, a gentleman in Canada encountered a brown bear; it sprung upon him in a plantation; he clasped his arms round it, and, being a powerful man, hugged it in return. Bruin was so surprised that he loosened his hold, and made his escape. White bear has larger feet, covered with long hair; why? *Food*, various: *the white*—fish, seals, seaweeds, marsh plants, and mountain berries; *the black*—vegetables and honey (“they’ll gnaw for days together at the trunk of a tree, till they make a hole big enough to get in their paws, and then they’ll haul out honey, bees and all”); *the brown*—flesh and vegetables.

IV. *Manner of Capture.*

Generally tracked by dogs; shot or speared. In Kamtschatka the hunters secrete themselves behind trees, and fire on their prey as it approaches them.

V. *Uses to which applied.*

a. Skin.—Very valuable for its fur; best ob-

tained from the black; fine and glossy; manufactured into gloves, military caps, rugs, muffs, and clothing generally.

b. Flesh.—Eaten; resembles pork.

c. Fat.—Made into “bears’ grease,” a pomatum.

d. Hide.—Yields the strongest leather.

e. Intestines.—Used for window panes, as a substitute for glass, by northern nations.

VI. Scriptural References.

Elicit from the children where they are mentioned; *e. g.*:—

1. Children of Bethel slain by two she-bears. (2 Kings, ii. 24.)

2. David slew one, preying upon his flock. (1 Sam. xvii. 34.)

3. The she-bear’s intense affection for her young noticed in Prov. xvii. 12; Hosea, xiii. 8.

LESSON XXV. — THE BEAVER.

ALLOW the children to examine a print of the animal, and then proceed to draw from them the particulars.

I. Appearance and Structure.

A quadruped; about two feet long, one foot high; covered with hair of a light brown colour; small eyes, far apart; upper lip cleft, like the hare’s; fore-teeth very strong — *Rodentia*; cuts down trees (by gnawing) six or eight inches thick; short legs; each of its four feet has five toes — hinder like the webbed feet of water-birds. Tail, very peculiar; half as long as its body; oval; destitute of hair or fur; resembles an oar; marked with scaly divisions like a fish.

II. *Countries where found.*

Common to Europe, Asia, and America; wanting in Africa. Generally found in the colder climates of these divisions — *e. g.*, on the banks of the Danube, Rhone, Elbe; Euphrates; St. Lawrence. Now extinct in England. In the tenth century it was met with in only one river in Wales and one in Scotland.

III. *Habits, Disposition, Food, &c.*

Social—lives in large companies of two or three hundred; amphibious. Inhabits extensive dwellings, nests or houses, built on the banks of rivers or shores of lakes; sometimes these are seven feet high, with walls nearly as thick; circular or oval; the domed roofs resemble ovens; from ten to thirty nests built together; uses its paws and teeth in constructing them; and its tail as a prop when standing erect; has retreats (holes), to which it retires when hunted. When no pond offers, chooses a flat piece of ground with a running stream; raises a dam with stakes and mud and clay; solid banks often very long; works during the night; lines the floor of its dwelling with moss. Provides a store of provisions for winter use; food consists of bark, tender branches, and water-plants. In summer they ramble in troops; when at home, a sentinel placed to watch—gives an alarm by a peculiar cry. A *builder*; the European variety has this power less developed, generally living in burrows. When domesticated, will build with brushes, boots, shoes, pieces of wood, books, &c.

IV. *Manner of Capture.*

Trapped in summer; sometimes taken in nets. Generally hunted in winter; hunters, armed with

ice-chisels, examine the banks of rivers or lakes, and cut holes in the ice wherever they suspect retreats in the bank ; others break open their houses ; they rush to their burrows ; these blocked up by the Indians with pieces of wood ; beavers captured when they rise to breathe. They are rapidly decreasing.

V. *Uses.*

a. Flesh.—Highly prized as food by Canadian Indians ; a dainty in Indian feasts ; tastes something like pork.

b. Skin.—Hats, stockings, caps, made from its fur.

c. Castor obtained from its body—a brownish substance employed in perfumery.

d. Dams occasionally used by the natives as bridges.

LESSON XXVI. — ADAPTATION OF THE STRUCTURE OF BIRDS.

I. *Their external Form.*

SMALL, round head ; sharp beak ; neck growing gradually thicker towards the shoulders ; gently swelling breast ; lengthened body ; *all adapted for piercing the atmosphere.*

II. *Their Covering.*

Plumage warm and light ; serves for *clothing*, as protection from the cold, and for *flight*. Feathers kept in order by oil supplied in a gland near the tail ; gathered up by pressure into the bill ; diffused over the surface ; throws off the wet. Water-

birds:—breasts and bellies covered with thick down; smooth, soft; *noiseless in passing through the water*. Feathers of the ostrich changed into hair-like covering; why? Exhibit a peacock's feather, and notice the beauty of the colours of some birds:—

“The glossy varying dyes,
The purpled crest, the scarlet-circled eyes,
The vivid green, the shining plumes unfold,
The painted wings, and breast that flames with gold.”

Note — “The covering of birds cannot escape the most vulgar observation;—its brightness, its smoothness, its warmth; the disposition of the feathers, all inclined backward, the down about the stem, the overlapping of their tips, not to mention their variety of colours, constitute a vestment for the body, so beautiful and so appropriate, that I think we should have had no conception of anything equally perfect if we had never seen it.”

III. (1) *Beaks*, (2) *Feet*, and (3) *Wings*.

1. *Beaks* of different birds suited to their habits; *e. g.*:—

a. Swallow's.—Thin; soft; wide at the bore; pointed; food consists of insects.

b. Duck's.—Broad; flat; fringed at the edge; food procured from the bottom of ponds, &c., out of the mud.

c. Snipe's.—Narrow; long; extremely sensitive, even to the point; serves the purpose of eyes, nose, tongue, and hand; by it they detect and secure their food.

2. *Feet*, very varied; contrast the foot of an eagle with one of a water-bird; latter web-footed; closed when drawn forward, opened to full extent when striking out; why? Waders have long legs

and necks, to secure their food in marshes and shallows.

Birds rest best *standing*; why?—the stretching of the muscles requires no effort.

Note.—“The moment a bird perches on a branch, the weight of its body causes the leg to bend at the joint; this bending tightens a set of muscles which descend to the toes; this stretching of the muscles causes the claws to contract round the substance on which the bird stands. Such is the simple and beautiful contrivance by which the smallest of the feathered race maintains its hold by one leg during the longest night.”

3. *Wings* display great design—lightness and strength combined; feathers thickest at the roots; why? Formed into hollow, tough quills; taper gradually where not needed so strong; wings worked by powerful muscles lying along each side of the breast.

IV. *Bones and internal Structure.*

Largest bones hollow and marrowless; lighter but not less strong; render the bird more buoyant. Cavities of the entrails also act as air vessels; filled with air from the lungs when the bird flies; this is rarefied by the heat of the body; what is the effect? Illustrate this by the action of gas upon a balloon.

V. *Lesson.*

How great the care of God for us, if He so careth for the birds of the air!—

“Birds! through the waste of trackless air
Ye have a guide, and shall we despair?
Ye over desert and deep have passed,
So shall we reach our bright home at last.”

LESSON XXVII. — THE BISON.

HAVING placed before the class a print of the animal, question out the particulars.

I. Its Appearance and Structure.

Peculiar species of ox ; called by the Americans "buffalo;" somewhat resembles it. Ponderous head—shaggy, woolly hair over the front ; long beard ; fore-quarter the larger ; sharp-pointed, straight, strong horns ; tail, a foot long ; eyes, fierce : —

" Fierce on the hunter's quiver'd band
He rolls his eyes of swarthy glow."

Altogether presents a savage, formidable appearance ; female, the smaller ; large, oblong hump over the shoulders. Covering, long fine hair, almost like wool ; dull, rusty-coloured ; lengthens as winter approaches.

II. Regions where found.

Common in the unsettled parts of the north and west of America,—north of the St. Lawrence ; west of the Mississippi. European species — Poland, Austria (Carpathian Mountains), Russia (Caucasian Mountains). Gradually retires as civilisation extends.

III. Habits, Disposition, &c.

Ruminant ; feeds upon the plains in the morning and evening ; retires to the forests during the day. Gregarious ; traverses plains and swims rivers in dense masses ; met with in herds of thousands (contrast with the ox, which leads a solitary life).

The male less vigilant than the female. Often fight together ; their roaring then resembles distant thunder ; when —

“ the bellowing war begins
Their eyes flash fury.”

Never attacks man but in defence.

IV. *Manner of Hunting and Capture.*

Numbers hunted and slaughtered for sport ; driven by the Indians over precipices, many killed in the fall ; grass around their feeding-place fired ; many crushed in endeavouring to escape ; two thousand have been so killed at a time ; snared by the *lasso*, i. e., a long cord with a running noose, thrown by a horseman.

V. *Uses.*

Indians nearly dependent upon it alone for subsistence.

1. *Flesh*. — Eaten ; superior in flavour, but coarser, than that of our domestic ox ; female's flesh the more tender ; the hump considered a delicacy.

2. *Skins*. — Dressed with the hair on, made into “buffalo robes,” blankets, and dresses, by the Indians.

3. *Hair*. — Manufactured into cloth, hats, stockings, &c.

4. *Hides* — into leather.

5. *Horns* — into powder-flasks.

Note. — “ Its flesh is their principal, sometimes their only, food ; eaten fresh on the prairies during their hunt, and dried in their winter villages. The skin is put to various uses ; it forms the material of their lodges, of their bales for packing

the meat, of their bed by night and their clothing by day ; — the coarser part they make into saddles or cut into halters. The sinews they use as strings to their bows, the smaller fibres for thread ; the hoof is made to answer the purpose of a mallet. The bones are used as scrapers and chisels ; others pointed for needles ; and the ribs furnish bows. The animal is essential to their existence ; when the ‘buffalo’ is exterminated the Indian of the prairies must perish.”

LESSON XXVIII. — THE CAMEL.

I. *Description of its external Appearance.*

ABOUT six feet in height ; brown, ashy colour ; covered with long, shaggy hair ; cushions upon the joints of the leg and front of the chest ; broad feet ; heavy eyelids ; long lips. Two varieties — the *Arabian* (the dromedary) and the *Bactrian* ; easily distinguished by the outline of their backs ; the former, one hump — the latter, two humps ; acute sense of smell, discovers water at a distance.

II. *Countries where found.*

In Europe—Southern Russia, Italy, and Turkey ; Asia—Arabia, Turkey, Persia, Tartary, and India ; Africa—South, Centre, Egypt. The dromedary is the more widely known. In America the llama is used as a substitute.

III. *Habits, Character, Food, &c.*

Gentle ; patient ; docile (receives its burden kneeling) ; becomes stubborn when beaten ; *rumi-*

nant (the cow, deer, sheep, camel and other animals which chew the cud, have *four* stomachs concerned in digestion: — the *first* receives the food after a slight mastication; thence it goes into the *second* (the honey-comb), and when it has lain for some time it is carried up again into the mouth; it is then chewed and passes into the *third* stomach, or manyplies, whence it goes into the *fourth*, or real, the proper digesting stomach); the *second* stomach consists of cells, solely appropriated to the reception of water; by means of a muscular structure these cells are closed and the water preserved from being mixed with the food. Lives from thirty to forty years. Travels about twenty miles a day. Food consists of herbage and foliage of shrubs; fed also with dates, barley cakes, &c. In spring, when the herbage is fresh, it can go for twenty-five days without water.

IV. *Structure adapted to its Habits.*

1. *Internal reservoir* supplies water when passing from oasis to oasis.

2. *Long neck* enables it to raise its head to catch the first glance of the distant verdure.

3. *Over-hanging eyelid* shelters the eye from the brilliancy of the sun.

4. *Long nostril* protects from the sand-blasts which sweep over the deserts.

5. *Loose, shaggy hair*; less warm than wool, but good defence to the skin.

6. *Broad feet* find ready support on the sand.

7. *Cushions upon feet, knees, and chest*, support the weight of the body while eating.

8. *Hump*, a mass of fat, substitute for food on lengthened journeys; large when well fed; decreases as food is withheld.

V. *Uses.*

a. Of the utmost use as a beast of burden ; called the “ship of the desert;” these wildernesses impassable without it ; by its aid men traverse regions—

“Where no springs in murmurs break away,
Or moss-crown'd fountains mitigate the day ;
Where rocks alone and tasteless sands are found,
And faint and sickly winds for ever howl around.”

b. The milk forms a nourishing and refreshing drink ; made also into butter and cheese.

c. Flesh supplies food to the Arab.

d. Hair manufactured into clothing and fabrics for tents ; the finer hair is imported into England, from Persia, for making painters' brushes.

VI. *Scriptural Notices.*

From the earliest times it has been a domestic animal ; frequently mentioned in the Bible—*e. g.*, enumerated among the riches of the patriarchs, Abraham, Job, Jacob, &c. ; on a camel Rebecca rode on leaving her home in company with Abraham's servant (Gen. xxiv.) ; camels' hair composed the simple dress of St. John Baptist (St. Matt. iii. 4) ; “a coarse stuff is still made from the long, shaggy hair of the camel.” The camel was the largest animal known to the Jews,—hence the proverb expressive of great improbability, “a camel to pass through the eye of a needle.” (*Vide* also Esth. viii. 10 ; 1 Sam. xxx. 17.)

LESSON XXIX.—CORAL.

I. *Description of Appearance, Nature, &c.*

LONG supposed to be a vegetable production, but it is really animal ; resembles bark, spotted with

round lumps ; covered with a thick adhesive substance. Living something like a tree ; consists of the dead bodies of insects, marine polypi ; *zoophytes*, animal-plants, or *zoantharia*, animal-flowers ; the most common the madrapore. Of various shapes and sizes, from a pin's head to the bulk of a pea ; some have the appearance of stars, with arms from four to six inches long ; others thin as threads, and several feet in length. Colour varies — yellow, blue, brown, &c.

II. *Formation.*

Their bodies adhere to each other ; increase upwards and extend laterally ; when left above high-water mark they die ; do not then decay, but harden and become as stone. When the tide is down, appear like rocks, compact, rugged, hard, and dry ; as the water rises the worms protrude themselves from numberless holes, and the mass appears alive.

“ I saw the living pile ascend
The mausoleum of its architects,
Still dying upwards as their labours closed ;
Slime the material, but slime was turned
To adamant, by their petrific touch ;
Frail were their frames, ephemeral their lives,
Their masonry imperishable.”

The principal coral-builders are found within twenty-eight degrees of the equator ; waters too cold for them beyond ; others in more temperate regions ; generally at about a hundred feet deep, never deeper than one hundred and twenty feet. “ There are few things more beautiful to look at than these corallines, when viewed through two or three fathoms of clear, still water. The colours of the rainbow are put to shame on a bright, sunny

day, by what meets the view on looking into the sea in those fairy regions."

"Millions of millions thus, from age to age,
With simplest skill and toil unwearable,
No moment and no movement unimproved,—
Laid line on line, on terrace, terrace spread,
To swell the heightening, brightening, gradual mound
By marvellous structure rising towards the day."

III. *Islands and Reefs.*

The whole Pacific crowded with coral-reefs and islands; the Red Sea is gradually growing less and less navigable in consequence of them. The surface of the island or reef gradually formed; only slightly elevated; "visited by sea-birds; salt plants take root; soil formed by degrees; cocoa-nuts and other seeds thrown on shore; land-birds visit it and deposit seeds of shrubs and plants; every high tide adds something to the bank; at last comes man to take possession."

"The sea-snatch'd isle is the home of men,
And mountains exult where the wave hath been."

Reefs of various forms; *barrier-reefs* run nearly parallel to the shore at some distance, separated by a smooth channel; *shore-reefs* fringe the shore, from which they are divided by a narrow strait. They are extremely dangerous to ships,—the surface generally under water, and sides steep, no warning of the danger can be discovered by sounding. The New Holland coral reef extends three times the length of England.

IV. *Coral Fishery.*

Fishery pursued extensively in the Mediterranean Sea, Persian Gulf, and Red Sea. Most celebrated

localities : the Straits of Messina, coast of Provence, shores of Sicily, Majorca, Minorca, and Africa. In the Lipari Isles, from eighteen to twenty vessels engaged ; quantity collected annually, three thousand pounds ; red and white varieties found—of the former there are nine different shades, from deep crimson to pale pink ; grows on the rocks like shrubs about a foot and a half in length. The net used consists of two pieces of wood fixed crosswise—loaded with lead—hemp or net twisted loosely round ; let down ; coral entangled ; drawn up into the boat ; dangerous operation, boat occasionally upset by the breaking of the line. Coral separated according to its quality ; some fetches a shilling per pound, other ten guineas per ounce (more than double the value of gold).

V. *Uses.*

1. Living coral supplies food for some species of fish.

2. Red coral manufactured into various trinkets and ornaments—much worn by the Arabs ; earrings, bracelets, necklaces, &c., made at Marseilles, and exported largely to the southern and eastern shores of the Mediterranean Sea. Counterfeit coral sometimes sold for the real ; cinnabar applied to the surface of wood, covered with size, and varnished with the white of eggs, a good imitation.

Note.—A fossil coral reef has been discovered at the falls of Ohio, Louisville, exactly similar to a modern formation.

VI. *Lesson.*

Elicit from the children the importance of little things and the performance of small duties, and let them learn :—

"Let each one do his part ; so each
May help Love's glorious work to do, —
Slow, as the Coral Islands teach,
But brighter it shall rise to view.

The little gift, the childish prayer
If given to God, by Him if blest,
May spring, and fruit more wondrous bear
Than Coral Isles in Ocean's breast."

LESSON XXX.—THE EAGLE.

I. *Description of Appearance and Structure.*

THE monarch of birds ; why ? About three feet long ; wings, when extended, measure six or eight feet ; bill, strong, hooked, and horny, about three inches long ; bright, fiery eyes ; acute, piercing sight—its double eyelid enables it to gaze upon the sun : —

"His wing on the wind, and his eye on the sun."

Legs, short, strong, yellow, feathered to the feet ; large claws, strong and curved, four upon each foot ; plumage varies according to age. Female only two thirds the size of the male. Many varieties—*e. g.*, imperial, golden, royal, crowned, white-headed or American.

II. *Countries where found.*

Found in Northern Europe, Africa (Abyssinia), and North America. In Great Britain—the Highlands, Orkneys ; Ireland — Achil Island (the *eagle* island). Formerly found in the Derbyshire and Westmoreland mountains ; very rarely seen in the *south* of Britain.

“The tawny eagle seats his callow brood
 High on the cliff and feasts his young with blood ;
 On *Snowdon's* rocks, or *Orkney's* wide domain,
 Whose beetling cliffs o'erhang the western main,
 The royal bird his lonely kingdom forms
 Amidst the gathering clouds and sullen storms.”

III. *Habits, Food, &c.*

Solitary ; ferocious ; daring ; its eyry (nest) formed of sticks, moss, heather, rushes, &c., constructed on the most inaccessible, jutting cliffs and rocks, or in forests upon the loftiest trees—very large, sometimes covers two square yards. Powerful ; rises in a spiral line out of sight in three minutes. “Bird of heaven :”—

“Thy home is on the mountain top,
 Thy fields the boundless air ;
 And hoary peaks, that prop
 The skies, thy dwelling are.”

Feeds upon fawns, hares, lambs and birds, killed by itself—descending upon them from a great height ; order *Raptores* or *Accipitres*. Disdains carrion :—

“The fairest of the fold he bears away,
 And to his nest compels the struggling prey ;
 He scorns the game by meaner hunters tore,
 And dips his talons in no vulgar gore.”

Some feed on *fish*—*e. g.*, the white-headed eagle will watch the *osprey* for hours, and when it (the osprey) has seized its prey, will pursue it till it drops the *fish*, after which it darts, and generally succeeds in securing it before it reaches the water. Lays two or three eggs ; of a dirty-white colour with brown spots ; each egg about three and a half inches long, and two and a half wide. Very careful of its young ; when teaching them to fly, will occasionally support them on its wings.

Notice its proud motions and commanding air ;

these induced many nations to adopt its figure as the symbol of power and dominion—*e. g.*, the standards of Rome, Persia, and Assyria; still seen on the flags of France, Russia, Austria, and Prussia.

IV. *Manner of Capture.*

Taken when young; stolen from the eyry during the absence of the parent birds. Shot occasionally, to prevent its preying upon flocks. Persons have lost their lives in attempting to secure eaglets—*e. g.*, a man was killed by the old birds while escaping with the young from an eyry in the Kerry Mountains.

V. *Adaptation of Structure to its Habits.*

Draw from the children a few of the wonderful ways in which its structure is adapted to its habits; *e. g.*:—

1. Shape and strength of its talons—for seizing prey.

2. Powerful beak—fitted for tearing the flesh of its victims.

3. Great strength of body (can carry nearly its own weight)—required for its support.

4. Piercing sight—enables it to distinguish prey afar off.

5. Large internal air-cells—make it capable of enduring long and fatiguing flights.

VI. *Scriptural References.*

Frequent allusion is made to this bird in the Sacred Scriptures; *e. g.*:—

- a. "I bare you on eagles' wings."—*Ex. xix. 4.* God's care for His people Israel—carrying them through danger.

b. "They (riches) fly as eagles."—*Prov.* xxiii. 5.

c. "They that wait on the Lord shall mount up with wings, as eagles."—*Is.* xl. 31. *Vide* also, *Lev.* xi. 13; *Job* xxxix. 28; *Dan.* iv. 33.

In the Christian Church the eagle is used as the emblem of St. John the Evangelist,—“who seems to have been constantly soaring up to heaven in holy contemplation; who was allowed to penetrate into the mysteries of Divine Truth, as if to teach us that love may be permitted to unfold that, which knowledge and even faith could not attain to.” (*Vide* *Rev.* iv. 7.)

LESSON XXXI.—THE ELEPHANT.

I. *Description of Appearance, Structure, &c.*

A QUADRUPED; the largest and strongest animal; general size about ten feet in height (some fifteen feet); small eyes in proportion to its enormous body; large ears—hearing acute, fond of music; large teeth (one will sometimes weigh four pounds); two tusks—project from six to seven feet—Gordon Cumming, the “Lion Hunter,” exhibits a specimen *ten feet nine inches* long; skin, hard and knotty, like the bark of a tree; legs, remarkably short and thick—terminate in round feet, each with five toes covered with horn. Most peculiar feature its proboscis; about eight feet long, proportionally thick; can move it in any direction, raise weights, gather up small articles, tie and untie knots, unlock doors, uproot trees, “kill a man, or brush off a fly;” the organ of respiration; by it supplies itself with food and drink. Lives to

the age of one hundred and thirty years in captivity — probably much longer when at liberty.

II. *Regions where found.*

Native of Asia and Africa ; not found wild in either Europe or America. Chiefly inhabits countries situated within the tropics — *e. g.*, Hindostan, Birman Empire, Ceylon ; found also about Cape Colony.

“Peaceful, beneath primeval trees, that cast
Their ample shade o’er *Niger’s* yellow stream,
And where the *Ganges* rolls his sacred wave ;
Or mid the central depths of blackening woods,
Lives the huge elephant—wisest of brutes !”

(Fossil teeth and tusks have been found in Great Britain and Ireland ; very common in Siberia, on the river banks ; the bones still left are supposed to exceed in number those of all the elephants living on the globe at the present time.) The *Indian* and *African* two distinct species ; the *latter* has a smaller head, convex forehead, lozenge-shaped teeth, longer tusks, enormous ears, and only three distinct toes on its hind feet.

III. *Habits, Disposition, Food, &c.*

Gregarious — met with in troops or herds of hundreds ; very sagacious — (illustration : one at Naples assisted the masons when repairing the palace by fetching water in copper vessels ; a vessel leaked, which it noticed, at once set off to the brazier’s shop with it, waited till it was mended, received it, and resumed its work). When tamed, gentle and docile : obeys the word or look of its cornac or guide ; kneels to allow persons to mount upon its back ; will play with children.

Revengeful of injuries — *e. g.*, the tailor of Surat and the elephant. Feeds upon vegetables — roots, herbs, grain, fruit, leaves, and tender wood ; very partial to sugar-cane, leaves of the banyan, cocoanuts, wine and spirits ; destroys great quantities of plants with its large feet and heavy body when it strays into cultivated grounds ; how kept away ? Consumes a hundred pounds of food daily.

“ Trampling his path through wood, and brake,
And canes, which, crackling, fall before his way,
On comes the elephant, to slake
His thirst at noon in yon pellucid spring.”

IV. *Manner of Capture.*

All tame elephants once wild ; never breed in captivity ; killed in pitfalls — in Sumatra by means of poisoned sugar-canes. Captured generally thus : a herd surrounded by hunters ; driven into an enclosed space ; pressed into a passage one at a time ; secured ; bound to trees ; supplied with food little by little ; reduced to subjection in a fortnight. In hunting them, the bullets used are of iron or tin ; why not of lead ?

V. *Uses.*

a. Used as *beasts of burden* in Eastern countries, strength immense — can perform the work of half a dozen horses ; also in state processions.

b. For forcing open the gates and battering down the walls of besieged towns.

c. Formerly in war : — swords were attached to their trunks, while on their backs were fixed wooden castles filled with armed men ; why was this practice discontinued ?

“ Beside him stalks to battle,
The huge, earth-shaking beast,—
The beast, on whom the castle,

With all its guards, doth stand,—
The beast, who hath between his eyes
The serpent for a hand.”—*Macaulay*.

d. Flesh supplies food ; the Abyssinians cut it into narrow pieces—hang it upon trees—when dried, stored for provision during the rainy seasons.

e. Tusks and teeth sold as *ivory* ; manufactured into numerous ornamental and useful articles—handles of knives and forks, chessmen, tablets, &c.

VI. *Adaptation of its Structure to its Habits.*

Notice the wonderful adaptation of its structure ; *e. g.* :—

1. *Its trunk* : instead of a long neck, which could not support its large head ; enables it to seize the boughs above, and the herbage beneath its feet.

2. *Its large ears* : protect the eyes from insects, dust, &c.

3. *Its legs* : very stout and strong ; why necessary ?

4. *Its docility and sagacity* compensate for its huge unwieldy body.

LESSON XXXII. — THE GIRAFFE.

I. *Appearance and Structure.*

CALLED also the camelopard ; resembles both the camel and the leopard ; how ? Fourteen to fifteen feet in height (compare this with some familiar object) ; tallest of known quadrupeds. Head, something like the horse's ; has erect horns, six inches long, with thick tuft of upright hairs on the top ; small mouth ; large, full, brilliant, but mild, eyes ; tongue, rough and pointed ; neck, long and slender ; very

deep shoulders ; short, stiff mane ; hoofs, cleft, without toes ; slender legs ; prominent knees. Ruminant. Colour, yellow-brown ; darker in male ; spotted.

II. *Localities where found.*

Found in the recesses of forests and upon the plains of Africa ; two species, one in Nubia and Abyssinia, the other in the southern part of the continent.

III. *Food, Habits, &c.*

Very delicate in its eating ; collects its food leaf by leaf ; eats only the top of gathered grass. Great cleanliness required to preserve it. In confinement, fed upon hay, carrots, mangel-wurzel, barley, beans, and onions. Timid, gentle ; fond of society (sheds tears at the loss of its companions), of flowers (those in the Zoological Gardens, Regent's Park, have often stolen the artificial flowers from the lady visitors' bonnets), perfumes, sugar, &c. Very quiet — believed to be perfectly dumb. Leaps rapidly, outdoing the swiftest Arab horse.

IV. *Manner of Capture.*

Very difficult to take ; its eyes peculiarly prominent — enable it to see on all sides the approach of an enemy. Hunted on horseback. Shot with poisoned arrows. Horns form powerful weapons of defence (*e. g.*, a female has been known to drive them through an inch board) ; a single blow often proves fatal to man.

V. *Uses.*

1. Its *flesh* is used for food by the Arabs ; the Hottentots hunt it for the sake of its marrow, which is considered a great dainty by them.

2. The *skin* is made into sandals and bucklers ; also converted into water-vessels.

VI. *Miscellaneous Observations.*

First brought into Europe by Julius Cæsar. One exhibited in Paris was admired by thousands,—fans, ribbons, dresses, were worn of its colour. Another at Constantinople, when led through the city, would stop at the houses where it had been formerly caressed. Very rare, even in a wild state. Partial to people wearing turbans or other oriental costumes.

Notice also the adaptation of its neck and tongue for gathering its food from the tops of trees.

LESSON XXXIII. — THE LOCUST.

INTRODUCE the lesson by reading the graphic description given by the prophet Joel :—

“ A nation hath gone up on my land,
Who are strong and without number ;
They have destroyed my vine, and have made my
fig-tree a broken branch,
They have made it quite bare, and cast it away ;
the branches thereof are made white.
The field is laid waste ; the ground, the ground
mourneth !
Now do the beasts groan !
The herds of cattle are perplexed, because they
have no pasture !
The land is as the garden of Eden before them,
and behind them a desolate wilderness ! ” —
i. 6, 7, 10, 18 ; ii. 3.

Then proceed to elicit :—

I. *Description of Appearance, Structure, &c.*

Belongs to the grasshopper class of insects. Produced from eggs nearly of the size of corn grains — about forty laid by each female. These remain buried in the ground during winter ; each produces a little worm, which afterwards becomes an insect of about three inches long ; back covered with strong corslet ; large, head ; two antennæ an inch long ; prominent, dark, rolling eyes ; strong jaws, with three teeth ; four wings—*exterior* the larger, tough and straight—the *under*, transparent and pliant :—

“ His outspread wings of green,
His gauzy under-wings,
One closely to the grass-green body furl'd
One ruffled in the fall and half unclosed.”

Eastern nations think they can read upon them, “ We are the destroying army of God.” Four front legs used in climbing and feeding ; the *hinder* pair larger and longer ; with them it can leap two hundred times the length of its own body ; how far ? Body of brown colour ; wings, blue, green, and tinged with red.

II. *Countries where found.*

Almost limited to Africa and Asia ; occasionally visits Southern Europe — Sicily, Italy, and Russia.

III. *Habits, Disposition, &c.*

Migratory ; moves in armies ; approaches as a dark opaque cloud ; clattering noise made by their wings.

“ Onward they come, a dark continuous cloud
Of congregated myriads, numberless,

The rushing of whose wings is as the sound
Of some broad river, headlong in its course,
Plunged from a mountain summit, or the roar
Of a wild ocean, in the autumnal storm,
Shattering its billows on a shore of rocks."

They fill the air like snow-flakes ; every vegetable substance disappears where they alight ; cultivated grounds become deserts ; trees are stripped of leaves, buds, and bark ; even the thatch of houses and poisonous plants are consumed : —

" And the trees are bare, and the land is brown,
As if trampled, and trod, by an army down ;
The broad, green earth is his prostrate prey,
And he darkens the sun at the noon of day."

They scale walls ; penetrate in swarms into granaries, houses, and cellars ; very unpleasant, striking and stinging the face in their leaps ; you cannot talk or eat without danger of receiving one into your mouth. Settle on the ground several inches deep ; crushed by the feet of horses and passengers ; dead bodies decompose and fill the air with pestilence : —

" Plague
Descends. From Ethiopia's poison'd woods,
From stifed Cairo's filth, and fetid fields
With locust armies putrefying heap'd,
This great destroyer sprung."

Famine and death also follow their visits ; whole districts thus depopulated — *e. g.*, in Numidia eight hundred thousand persons perished by pestilence and famine occasioned by them. Great efforts made to prevent their descent on fields and gardens, and to destroy them after settling ; noises made by men, women, and children — ringing bells, firing guns, beating drums, cracking whir-

— all to frighten them off. Sometimes, when tired, they fall into seas, rivers, or lakes. Devoured by birds, lizards, hogs, frogs, and foxes. Millions destroyed by tempests, heavy rains, and cold winds. When they alight a deep trench is dug, three or four feet wide, lined on the off side by people holding brooms, sticks, shovels, &c.; others surround and drive the insects towards their open grave, into which they are brushed and buried.

IV. *Uses.*

Considered wholesome and nutritious by Eastern nations; eaten by Arabians, Hottentots and New Hollanders. In Southern Africa a brown soup made of their eggs; the Bedouins collect, dry, salt, and sell or eat them; dried and pounded, they are made into bread by others.

V. *Scriptural References.*

1. Placed among the “clean” — allowed to be eaten. (Lev. xi. 22.)

2. Constituted in part the food of St. John Baptist — proof of his poverty. (St. Matt. iii. 4.)

3. One of the terrible plagues sent upon Egypt. (Ex. x.): —

“The locusts, from their wiry way,
With reptile war assail their proud abode,
And mar the giant pomp of Egypt’s gods.”

4. Name used for the enemies of Christianity. (Rev. ix. 3.)

Note. — “Fancy a heavy fall of snow, each flake being a black, voracious insect, and these, as they fall, covering the ground to the depth of two or three inches, while the air still continues obscured by the myriads that remain fluttering about, — the roofs of the houses and every inch of ground covered

by a thick mass of crawling, crackling vermin, hissing and buzzing. Every aperture of the house may be carefully closed, yet they come down the chimney by thousands, and beat against the windows like hail. During the locust years many of these swarms settled on Odessa, covering the streets and public places ; dropping by hundreds into the kettles and saucepans in the kitchens, invading at once the drawing-room and the granary, and crawling along the public walks by millions. The sudden darkness occasioned by a swarm of them on a fine day is quite as great as would be occasioned by a succession of rainy clouds ; not a ray of sunshine can pierce through. When they alight on a tree it will seem ready to break under the sudden load, and so much ground is covered by their armies that it is calculated that these swarms must consist of a thousand millions. When at length they depart, they leave behind them a scene of desolation, such as no other calamity could produce."

LESSON XXXIV. — THE OSTRICH.

I. *Appearance and Structure.*

PLUMAGE of a deep glossy, black colour, with white feathers in the tail and wings ; the female has dusky plumes. Seven feet in height (some attain nine feet) ; dead body weighs between two and three hundred pounds ; neck, very long, and destitute of feathers ; eyes, prominent. Greatly resembles a *quadruped* ; jointed, naked legs ; cloven hoofs, the toes of unequal length—the one four, and the other seven inches ; gruff voice ; bears a striking likeness to the camel, in its feet and stomach — both subsist on scanty vegetation ;

called by Arabs and Persians the "camel bird ;" wings, imperfect.

II. *Regions where found, &c.*

Inhabitant of Central Africa and Arabia ; its abode is —

"A region of emptiness, howling and drear,
Which man hath abandoned from famine and fear ;
Which the *Ostrich* and lizard inhabit alone,
With the twilight bat from the old, hollow stone."

Occasionally intrudes on cultivated grounds ; does great damage. Hunted on horseback : hemmed in by horsemen ; chased backwards and forwards till exhausted ; despatched by blows on the head. In South Africa, often chased on foot, and shot whilst drinking. Preyed upon by lions, panthers, &c. ; eggs eaten by hyenas.

Birds somewhat similar in their appearance and structure are found in other parts of the world, as the *cassowary* in Asia, the *emu* in Australia, the *rhea* in South America, and the *bustard* in Europe.

III. *Habits and Food.*

Lives from twenty to thirty years. Possesses enormous strength ; a single blow from its foot will prostrate a hyena, panther, jackal, or wild dog. Exceedingly swift, outrunning a horse — "she scorneth the horse and his rider :"

"Along the wilderness she skims, with speed,
And scorns the rider and pursuing steed."

Cry resembles that of the lion. Lays from twelve to sixteen eggs (several birds deposit their eggs in the same nest) ; the nest is a cavity scooped out in the sand ; both birds sit. Gregarious—seen in troops of fifty at a time ; associates with quadrupeds. Easily domesticated. Very voracious ;

food consists of grain, seeds, grass, and the tender foliage of plants; when tame, fed upon oats, barley, chaff, and cabbage, mixed. In confinement, has been known to swallow stones, pieces of metal, leather, wood, spoons, knives, &c.—hence called the “iron-eating ostrich;” why does it swallow such substances?

IV. *Adaptation of its Structure.*

Notice that the *covering of the young* is admirably adapted to harmonise with the sand, being of a “pepper and salt” colour—thus it frequently escapes observation; its *prominent eyes* prevent its capture to great extent; *the wings* assist its running, but are not suited for flight, the barbs of the feathers having little adhesion.

V. *Uses.*

1. *Its flesh* supplies food to the Africans; not eaten by Arabs, and forbidden to the Jews.

2. *The eggs* are highly prized, both by the natives and travellers; weigh about three pounds; contain as much as two dozen hens’ eggs. Sold in Algiers at from three to five francs each.

3. *The egg-shells* are formed into vessels for liquids; covered with network; much used by the Bushmen.

4. *The feathers* are very valuable; an article of export; sold for from two to twelve guineas a pound, according to their quality; a pound contains about eighty. Chiefly exported to France.

5. *The skin* is hard, tough, and strong; used for armour by the Arabs.

6. *Skin and feathers* made into mats, rugs, &c.; very costly; one was sold in France for six hundred francs.

LESSON XXXV. — THE OYSTER.

I. *The Shell and its Inmate.*

COMMENCE the lesson by drawing from the children the names of shell-fish generally; remind them how numberless are these inhabitants of the ocean—fifteen thousand distinct kinds of shells have been named by *choncologists*; obtain the etymology of this word—*concha*, a shell, *logos*, a discourse, and the affix *ist*, a doer. These shells all differ in shape and colour, yet each is formed in the same manner, and each the residence of a soft delicate animal.

Direct their attention to the *oysterlings*: first cast upon the waters like drops of grease, the spawn or eggs; when viewed through a microscope, appear of brilliant whiteness; carried to and fro by every wave; subject to the attacks of large and small fish, on every side; yet leading a roving and unsettled life—

“Where the sea-flower spreads its leaves of blue,
That never are wet with the falling dew,
But in bright and changeful beauty shine
Far down in the deep and glassy brine.”

Many of these “spats” unite and adhere to rocks and old shells; form large *banks*. Its shell *bivalve* (name others; also some that are univalves, &c.)—etymology, *bis*, twice, and *valvæ*, doors—formed of two parts; increases in size and thickness annually; the age of the oyster is calculated by the number of layers or “shoots” on the shell—each marking a year’s growth. It possesses also a powerful *muscle*, which enables it to close its shell with great force; and a *beard*, which consists of minute fibres, serving as lungs.

II. *Food.*

Notice the fact of its being *headless*, and elicit from the children its mode of taking food; how this is supplied, itself being unable to move. The mouth of the oyster is near the hinge; its food animalcula; each wave and billow, therefore, sweeping through the open shell, brings with it meat, drink, and air, which are sucked in by the little rays around that part. Thus they, at the return of the tide,—

“In their pearly shells, *at ease*, attend
Moist nourishment.”

III. *The Fishery.*

Britain celebrated for them from the most ancient times; principal fishery at Preston Pans, near Edinburgh—produces the famous Pandore oyster—small in size, but fetches the highest price; those taken from the Irish coasts larger. British Channel very noted; oysters the staple export of Jersey—these are about five inches in diameter; chief seat of the fishery, *Gorey*, a small seaport on the eastern coast; season commences with September and ends with May—at its height in February and March; oysters exported during these months to the value of five thousand pounds weekly employing three thousand persons, and five hundred vessels. Stored in “*parks*” on the coasts of Essex, Sussex, and Hants—*e. g.*, at the mouths of the Thames, Crouch, Blackwater, Colne, &c.; thence supplied to the various markets; sent also to Hamburg, Bremen, Holland, France, &c.

Pearl fishery: chiefly in the Persian Gulf, on the coasts of Australia and Japan, and the Gulf of California. Most celebrated and productive in the

Bay of Condatchy in Ceylon; employs six thousand men; banks extend over a space thirty miles long by twenty-four broad.

IV. *Adaptation of its Structure.*

Recapitulate the lesson, and notice the wisdom displayed in its structure; *e. g.*:—

1. The powerful *muscle* by which it defends itself against the attacks of its enemies — the star-fish, lobsters, mice, rats, and monkeys; has been known to kill a mouse, and even a rat, and to cut off a finger of the star-fish by closing its shell with great firmness.

2. The enlargement of the shell is equal to the size of the little inmate; the increase in size ceases when the oyster reaches maturity; then *thickened* by layers on the outside; by these it is protected from the whelk, which most industriously bores holes through the shell.

3. The *beard*, with its millions of minute fibres (invisible to the naked eye), all endowed with life, and beating with the most perfect regularity, shows the Almighty power of the Great Creator.

LESSON XXXVI. — THE REINDEER.

I. *Description of Appearance, Structure, &c.*

QUADRUPED; about four feet in height; body of thick, squarish form; long, slender, branching, palmated horns. Brown-coloured above; white beneath; greyish-white when old, sometimes mottled; coat thickens and changes to a lighter colour as winter approaches; why? Fur very thick under the neck. The male, the larger; horns

common to both male and female; why necessary? Hoofs, long, broad, cloven, black and spreading; form excellent snow-shoes for the animal. Has exquisite sense of smell; why so endowed? enables it to find its food under the snow. Broad antlers protect its eyes.

II. *Countries where found.*

Common in the Arctic regions of the Old and New World.—Lapland, Norway, Siberia, Kamtschatka, Greenland. Domesticated by the Lapps.

III. *Habits, Disposition, &c.*

Ruminant; feeds during summer on the green herbage; in winter its only food mosses (*reindeer* moss; white and branched; grows many inches deep; covers miles of surface; another species pendent from the branches of trees like locks of hair); how procured? Casts its horns every year; in summer driven to the sea-coasts or tops of mountains, to escape the attacks of the gad-fly, which pierces its skin till it resembles a colander. Very swift; general trot, ten miles an hour; can go nineteen miles:—

“With blue, cold nose and wrinkled brow,
Traveller, whence comest thou?
From Lapland's woods and hills of frost,
By the *rapid* reindeer cross'd.”

Generally lives about sixteen years. Gregarious; difficult to tame; when domesticated, docile:—

“The docile tribe
Yield to the sled their necks, and whirl them swift
O'er hill and dale, heap'd into one expanse
Of marbled snow.”

IV. *Manner of Capture.*

Taken by stratagem. The Esquimaux hide behind rocks, imitate the bellowing of deer; the inquisitive animals approach and are shot. Sometimes driven into the water and speared. Indians disguise themselves in the skin and antlers, and shoot the finest and fattest of the herd.

V. *Uses.*

1. *Renders Lapland habitable*; no travelling without it; harnessed to sledges, it transports goods and people from place to place.

2. *Constitutes the sole wealth of the Lapps*; a man is rich if he possess a thousand; can obtain a living with a herd of two hundred; a hundred insure only a precarious subsistence.

3. *Flesh* supplies them with food — venison.

4. *The milk*, very rich — like cream; small frozen blocks taken by the Lapps on their journeys.

5. *Horns* made into spoons.

6. *Hoofs and horns* made into glue.

7. *Skin and fur* made into entire suits of the warmest clothing — bedding and tents.

Compare its use to this people with that of the camel to the Arab, the horse to the Tartar, the pig to the Irishman, the cow to the Englishman, and the dog to the Esquimaux.

“ Their reindeer form their riches. These their tents, Their robes, their beds, and all their homely wealth Supply, their wholesome fare and cheerful cups.”

LESSON XXXVII.—THE SABLE.

I. *Description of Appearance, Structure, &c.*

OBTAIN much of this from the children after allowing them to examine a print or specimen of the animal. Resembles a weasel or marten in size and form; about eighteen inches long. Small oval head—round ears—long whiskers; large feet—five toes—white—hooked and hard-pointed claws. Covered with dark fur (commoner kinds have light fur under their throats). Bushy tail, five inches long.

II. *Habitat.*

Found in woody districts (*e. g.*, forests of fir) of the northern regions of both the Old and New World—Siberia, Kamtschatka, Hudson's Bay territory. Russia produces about 25,000 skins annually.

III. *Habits, Disposition, Food, &c.*

Lives in holes under the roots of trees; sleeps during the day; very active and lively in the night. Courageous, attacks larger animals than itself. Omnivorous; feeds on weasels, hares, squirrels, and partridges generally—in autumn on fruits and berries. Female bears from three to five young ones about March. Very docile and intelligent; has been domesticated.

IV. *Manner of Capture.*

Hunted in the months of December, January, and February; taken in pits, nets, and traps. Hunters assemble in large companies; offer prayers for success; are subdivided into smaller parties of five or ten; set out carrying provisions, cook-

ing apparatus, &c.; mark the trees as they proceed; why? Set traps on their way; revisit them; take out their prey and reset them. Nets sometimes watched for days. Men suffer greatly from want of rest and food—also from the severity of the climate.

V. *Uses.*

Supplies very valuable fur; the coat is generally *brown*, sometimes *tawny*, and occasionally quite *white*; the skins having the longest and darkest hairs considered the best. (Notice our adjective *sable*, black or dark, as *sable* plumes). A skin about four inches broad sells for from one to ten pounds. Dyed skins often sold by the Chinese as the real.

LESSON XXXVIII.—THE SILK-WORM.

I. *Description of Appearance, &c.*

In its *first* state, a very small, flat *egg*; hatched into a *caterpillar* (its *second* stage)—the *larva* (a *mask*); why so called? because an insect or butterfly *in disguise*; at first very small, about the size of a grain of mustard seed—when full-grown about three inches long. Covered with twelve rings; has sixteen legs; fourteen eyes—seven on each side of the head.

II. *Localities where reared.*

It is kept and carefully reared in warm countries—*e. g.*, China, India, Persia, Turkey (Asiatic and European), Italy (Naples, Tuscany, Lombardy, Sardinia), Austria (Illyria), France (especially around Lyons). In England, on account of the

climate, only for amusement. The Chinese keep the caterpillars in large clean rooms, heated artificially, in trays, carefully attending them day and night; occasionally the cocoons are spun upon the branches of trees.

III. *Habits, Food, Changes, &c.*

The caterpillar, till arrived at maturity, eats most voraciously; devours quantities of the leaves of the white mulberry tree. When eight days old, changes its skin; why? Rests about two days; recommences eating; changes its skin *four* times. When full-grown, ceases to eat; commences spinning a nest, house, or *cocoon* (from the French *cocon*, "a ball or pod") — a small silky bag, consisting of fine silken threads drawn from its mouth — these are very long, some nearly a thousand feet; finished in two days; now resembles a firm, yellow ball (its *third* stage) — a *chrysalis* (from the Greek *chrysos*, "gold" — golden-tinted) or *pupa* (meant originally a baby-doll in swaddling clothes), the insect in a torpid state — a grub, without visible mouth, legs, eyes, or wings; remains thus for three or four weeks; throws off the cocoon and re-appears a *moth* — the perfect insect — beautiful and delicate-coloured. Lays eggs and dies. Question out the four different forms under which it appears — the *egg*, *caterpillar*, *chrysalis*, and *moth*. The eggs are collected and carefully preserved in bags, bottles, &c.; have the appearance of seeds till the following spring; often removed to colder districts, filled into bottles, which are sealed and immersed in cold water; why? Also hatched by means of artificial heat — *e. g.*, in heated rooms, and in bags carried about the person.

IV. *Lessons.*

Recapitulate the whole of the lesson, and draw from the children that it leads us to admire the wisdom of God, which is so wonderfully displayed in the habits, &c. of this little insect; *e. g.* :—

1. The silkworm the only insect that feeds on the mulberry leaf.

2. It does not wander like other caterpillars; the raw silk is therefore more easily secured.

3. It is hatched simultaneously with the budding of the mulberry tree; the young and tender foliage is consequently adapted to its age.

The following poetical resumé by Cowper may be given as a dictation lesson, and afterwards committed to memory :—

“ The beams of April, ere it goes,
A worm scarce visible disclose ;
All winter long content to dwell
The tenant of his native shell.
The same prolific season gives
The sustenance by which he lives —
The mulberry leaf, a simple store,
That serves him till he needs no more ;
For, his dimensions once complete,
Thenceforth none ever sees him eat ;
Though, till his growing time be past,
Scarce ever is he seen to fast.
That hour arrived, his work begins,
He spins and weaves, and weaves and spins,
Till circle upon circle, wound
Careless around him and around,
Conceals him with a veil, though slight,
Impervious to the keenest sight.
Thus self-enclosed, as in a cask,
At length he finishes his task ;
And though a worm when he was lost,
Or caterpillar at the most,
When next we see him wings he wears,
And in papilio pomp appears ;

Becomes oviparous ; supplies
With future worms and future flies
The next ensuing year — and dies.

Well were it for the world if all
Who creep about this earthly ball,
Though shorter lived than most he be,
Were useful in their kind as he."

LESSON XXXIX. — SPONGE.

I. *Appearance, Qualities, &c.*

ELASTIC and highly porous substance ; the skeleton of an animal ; consists of a large number of fibres ; resembles net-work. The best, softest to the touch and palest in colour, with very small holes ; when alive, of a dull bluish colour above, and white beneath. Several varieties.

II. *Formation.*

Produced by minute polypi ; when living, resemble jelly ; adhere to and cover the surface of rocks, shells, &c., under water at various depths between three and thirty fathoms ; line the walls of caves or "hang in living stalactites from the roof ;" a constant stream of water flows through them.

III. *Whence obtained.*

Widely diffused ; every coast furnishes some kind, from the poles to the equator ; more abundant and larger in the warmer zones. Best taken among the Cyclades. Principal markets, Smyrna, Rhodes, Napoli, Constantinople, Beyrout, Latakia, and Tripoli ; these markets are visited by merchants from every part of the world, and present

busy and exciting scene; "the sponge is everywhere; baskets of sponge, piles of sponge, trays of sponge, pyramids of sponge, make up a picture that fixes itself in the memory for a lifetime." Inferior obtained from the coast of Barbary. The Island of Nicaria is supported by the fishery. Largely exported from the Bahamas and Florida.

IV. *Fishery.*

The fishery is conducted by little fleets of boats; each boat manned by six or eight men; all dive in succession; the diver seizes a large stone attached to a rope; plunges head-foremost from the stern; why? descends more quickly; remains down between one and two minutes; detaches the sponge; is drawn up by his companions. The sponges brought up in a netted bag, into which the diver has gathered them. A diver will sometimes collect fifty *okes* in a day, (about a cwt.); a very large sponge will weigh two *okes*; the weight is calculated when dried. Cup-shaped when taken; slimy animal matter pressed out with the feet; washed; dried; packed in casks with sand.

V. *Uses.*

Notice its use for domestic purposes in washing and cleaning; employed also in medicine, as "burnt sponge."

LESSON XL.—THE TIGER.

I. *Appearance, Structure, &c.*

ALLOW the children to examine a print of the animal, and then question out the particulars.

Resembles the wild cat in appearance and habits ; our domestic cat has been called a "miniature tiger." Digitigrade, from Latin, *digitus*, "a finger," *gradus*, "a step" — uses only its toes in walking. Beautifully variegated skin—orange ground, striped with black ; cheeks, white ground, black stripes. Royal Bengal tiger fifteen feet long from its nose to the tip of its tail.

II. *Countries where found.*

Confined to Asia ; chiefly seen in India and southern countries ; met with occasionally in Siberia, near the source of the Obi. Frequents thickets in the vicinity of lakes and rivers ; why ?

III. *Disposition, Habits, &c.*

Carnivorous ; exceedingly fierce ; most sanguinary ; strength immense—(illustration : known to have drawn a buffalo from a quagmire, which several men had failed to do). Tigress displays great affection for her young ; braves every danger to recover her cubs if stolen ; will remove those she can rescue to a place of safety, return and pursue the plunderers even to the city gates or to the sea-shore. Its howling most terrible. Conceals itself near rivers or springs, whence it bounds with a roar upon its victim : —

" Darting fierce,
Impetuous, on the prey his glance has doom'd."

May be tamed when taken young ; becomes very fond of its keeper. One was trained to sleep with the sailors in their hammocks. Dangerous if it taste human blood ; attacks man afterwards when opportunity offers ; will drag a rider from his horse for prey. Fearful of shrill sounds or un-

usual noises — (illustration : the roads of Java are cleared for the passage of great personages by the blowing of horns).

IV. *Manner of Capture.*

Being so destructive and fierce, many means have been adopted for destroying it. Notice a few ; *e. g.* : —

1. A spring-bow discharges a poisoned arrow when the animal treads upon a string.

2. A heavy beam suspended over its track with a cord attached ; while disengaging itself from the latter, the beam descends and crushes it.

3. The leaves of a tree smeared with gum, similar to bird-lime, strewn in its track ; these adhere to its feet ; rolls over and over, roaring ; easily killed by the peasants. Tiger hunting in India carried on in great state ; large parties on elephants and horses pursue it, armed with lances, spears, sabres, guns, and pikes.

V. *Use.*

Skin dressed and made into beautiful rugs ; highly esteemed by the Chinese ; why ? (yellow the imperial colour). In England, used as hammer-cloths for carriages.

VI. *Adaptation of Structure.*

Notice the wisdom displayed in the adaptation of its structure to its habits ; *e. g.* : —

a. Its *feet* : lined with elastic pads (prevent noise when seeking its prey) ; a soft paw for its young, but sharp and destructive to its enemies ; furnished with large retractile claws.

b. *Eyes* : suited for nocturnal habits.

c. *Colour and stripes* : not easily distinguished

from the dark stems of the trees among which it lurks.

LESSON XLI.—THE WHALE.

I. *Appearance, Structure, &c.*

LARGER than any land animal; “the monarch of creation;” resembles in appearance a fish; in reality belongs to the *Mammalia*—*Cetacea*. Contrast it with a *fish*, which is oviparous (young produced from ova or eggs)—cold-blooded—respires through the gills—dies when brought into the air; the *whale*, viviparous—cubs nourished with milk—has no gills, but *lungs*, similar to land animals—breathes air, dies when deprived of it (*i. e.* is *drowned*)—warm-blooded. True *Mammalia*. Well adapted for its habitation—*e. g.*, fins substituted for fore-legs or arms (notice the resemblance between the bones of the fin and those of the human hand); tail, *horizontal*—enables it to rise easily to the surface; skin, capable of bearing great pressure; why necessary? Possesses a coating of fat—the blubber—covering the whole body; resists cold while its lightness adds to the buoyancy of the animal; “it operates like so much caoutchouc.” Many species—the three principal, (*a*) Greenland, (*b*) Rorqual, and (*c*) *Spermaceti*.

a. Greenland.—Length, between sixty and seventy feet—circumference, thirty or forty; mouth, large—sixteen feet long, three wide, and ten high (capable of holding a boat full of men); blow-holes in the head, a foot long; no teeth, but *baleen* (commonly called *whalebone*) a substitute; colour, grey, white, or black; blubber covers the whole body—from eight to twenty inches thick—resembles sal-

mon flesh—filled with oil. Full age, about twenty years.

b. Rorqual.—Largest of the Cetacea ; longer body, from ninety to a hundred feet—blubber thinner—more active—bolder than the Greenland ; toothless—less baleen—larger throat ; blubber of a bluish hue.

c. Spermaceti.—Seventy or eighty feet long ; no baleen, but teeth in the lower jaw ; large head, one third of its body ; huge tail.

II. *Regions where found.*

The Greenland and Rorqual found in the Polar Seas—shores of Greenland, Baffin's Bay, Davis' Straits, Nova Zembla, Spitzbergen—

“In thrilling regions of thick-ribbed ice.”

The Spermaceti generally taken in the Southern Ocean.

III. *Habits, Food, &c.*

Breathes through blow-pipes ; respire less frequently than man ; will remain below the surface an hour ; blows violently, throwing up a fountain visible three miles off ; moves at the rate of five miles an hour ; swims with its huge jaws extended, gathering various animalcula—shrimps, small crabs, lobsters, sea-snails, &c. ; these are entangled in the *baleen* (sketch its position in the upper-jaw and show its adaptation). Rorqual and Spermaceti feed also upon herrings, pilchards, haddocks, cod-fish, &c. Possesses no voice—“whales have no voice.” The Spermaceti whale is gregarious—found in herds or “schools” of from two to six hundred :—

“Huge of bulk,
Wallowing unwieldy, enormous in their gait,
Tempest the ocean.”

IV. *Manner of Capture.*

Capture miscalled *fishery*; why? Generally taken by Lapps, Finns and Greenlanders, also by whalers from Great Britain and America. The Rorqual occasionally taken in the estuaries and bays of our coasts, where they follow the herring shoals. *Whalers*, very strongly built ships; crew consists of about fifty men; each carries half a dozen boats; sail in spring (many from Peterhead, Scotland). Each boat has a harpooner; quantity of rope attached to a harpoon (sketch this instrument), generally four thousand feet; boats set to watch; whale discovered, pursued, struck by the harpooner—dives rapidly (cord runs out so fast that it requires to be wetted to prevent taking fire from friction)—rises to breathe—wounded by the harpooners of the other boats; when killed, drawn to the ship; blubber cut off in blocks, packed into casks; baleen removed; carcase of flesh and bones left to the sharks, bears, &c.

V. *Uses.*

Among uncivilised nations it is extremely useful; its flesh furnishes food to the people living on the shores of the Arctic Ocean—*e. g.*, the Esquimaux eat its flesh and drink the oil obtained from the blubber. The bones are made into harpoons and spears, and assist also in the erection of tents; sinews supply thread; membranes of the intestines serve for windows in their huts; teeth highly prized by the South Sea Islanders, who offer them to their gods.

From it we obtain : —

1. *Oil*.—Extracted from the blubber by heat ; about three tons obtained from four of blubber ; sperm oil from the *Spermaceti* whale.

2. *Whalebone*.—Not *bone* ; as much as a ton taken from a large whale ; applied by us to many useful purposes.

3. *Spermaceti*.—Used chiefly in the manufacture of candles — when refined, in medicine.

4. *Ambergris*.—Found in the intestines ; used in perfumery ; very dear—sold sometimes for twenty shillings an ounce.

5. In Holland *glue* is made from the tail.

MANUFACTURES.

LESSON XLII. — GLASS.

I. *Description of Appearance, Qualities, &c.*

MANUFACTURED substance ; transparent ; white, green, or coloured ; extremely brittle ; impermeable ; when heated, flexible, tenacious, and ductile.

II. *Invention of the Manufacture.*

Probably by accident : crew of ship laden with nitre landed near Acre ; when dressing their food, placed their cooking vessels on blocks of nitre, over a fire of sea-weed ; heat melted the nitre ; this fused with the sand, and produced a stream of partly transparent matter — the first glass. Discovery made very early ; articles of glass have been

found in the ancient, ruined cities of Egypt ; was known to the Tyrians, also to the Chinese (an antique glass vase from China in the British Museum) ; used by the Romans — found in the remains of Herculaneum. The Venetians obtained great riches from its production. . Manufactured in England in the sixteenth century ; of high value and great rarity, glazed windows were removed from the casements and packed in boxes, when a family removed from town into the country. Although an ancient art, its numerous and beautiful adaptations are of recent origin.

III. *Materials employed.*

Chiefly three articles — (a) sand, (b) an alkali, and lime ; the last is used as a *flux* to unite the others.

“ Go, gather the sand at the ebb of the sea,
And the ashes that fall from the charr’d forest tree ;
Can ashes and sand, vile and dark to the view,
Gain the clearness of light, and the softness of dew ? ”

a. Sand, a substitute for flint ; hence *silicious* sand only suitable ; supplied from certain districts ; brought occasionally from Australia and America ; principally procured from Alum Bay (Isle of Wight), King’s Lynn, and its vicinity.

b. The alkali may be soda, potash, or pearlash. *Soda* : procured from salt or from the ashes of plants grown near the sea. *Potash* : sediment deposited by water in which the ashes of plants have been soaked. *Pearlash* : similar to potash ; more refined by washing, evaporation, and roasting.

IV. *Process and Results of the Manufacture.*

These materials compounded in proper proportions ; put into crucibles or furnaces ; intense heat applied ; fused ; purified ; in two days and nights the mass becomes transparent ; cooled to the consistency of *paste* ; ready for the workman. Principal varieties produced are five — (1) Flint, (2) Plate, (3) Crown, (4) Broad, and (5) Bottle.

1. *Flint*.—Formerly *flints* were used—now sand, or nitrate and silicate of lead, with pearlash ; great weight—superior density—hence best for telescopes ; very brilliant, often called crystal.

2. *Plate*.—Manufactured in large *plates*—from sand, soda, lime, nitre, old plate-glass. When fused and purified, poured upon tables ; rolled into sheets by iron rollers ; placed in *annealing* oven for fourteen days ; very gradually cooled, to overcome its brittleness (this is done to all glass).

“But brightness and clearness will never suffice
To give to our vessels their beauty and price ;
Quick hearts should be gentle,—join firmness with zeal ;—
All lost is our labour, except we *anneal*.”

Next cut ; ground with powdered flint, to remove roughness ; polished with cloth rollers and oxide of iron.

3. *Crown*.—German sheet-glass ; best description of common window-glass ; harder and lighter than others. From sand, kelp, lime, and crown-glass ; pearl-ash and soda sometimes substituted for kelp. Formed into circular plates by blowing and whirling ; the centre knot the point joined to the rod.

4. *Broad*.—The common window glass ; of

cheaper and coarser materials ; blówn into a cylindrical form ; cut open ; spread into a flat plate.

5. *Bottle*.—Cheapest materials,—often made from sea-weed and lime only ; salt supplies the place of the alkali.

V. *Localities of Manufactories in Europe.*

In England—Newcastle-on-Tyne, Shields, Stourbridge (Worcestershire), Ravenhead (Liverpool), St. Helen's, Bristol, Warrington, Birmingham, Leeds, and Lambeth.

On the Continent—Berlin, Paris, and Antwerp.

VI. *Applications.*

Most useful and beautiful material for *glazing windows*—excluding cold, rain, snow and storm, while admitting light and sunshine. Compare a home of the olden time and one of our own day—the superior comfort of the cottage now in this respect to the lordly castle of that time. Draw out the uses to which it is applied in *science* ; in *optical instruments* ; in *domestic purposes*, supplying elegant, wholesome, and clean vessels of various kinds ; in *ornament*—stained glass, the windows of abbeys, churches, and cathedrals : —

- “ The storied windows richly dight,
 Casting a dim religious light ”

over these sacred edifices, greatly enhancing their beauty ;—

- “ The windows purple, red, and green—
All radiant with celestial sheen,
That seize the sun-robe by its hems
And twist and cut it into gems.”

In the manufacture of *paste* for artificial gems, —a

composition of glass, containing much oxide. In *looking-glasses, reflectors, &c.* Extensively used in buildings—*e.g.*, the Crystal Palace, &c.

LESSON XLIII. — LUCIFER MATCHES.

I. *Introduction.*

NOTICE the necessity for fire and the various methods used to obtain it; *e. g.* :—

1. That adopted by the savage—rubbing pieces of dry wood together—flame produced by *friction* and communicated to dry leaves, &c. This is a rude, laborious, and uncertain mode.

2. The old and obsolete method once in general use in this country — “striking a light” by means of the flint, steel, and tinder-box; sparks emitted by the flints,—

“The hidden fire in veins of flint,”—

tinder ignited, and a light obtained by means of a match. An improvement upon the olden plan but still very imperfect; it involved a great loss of time.

3. Both superseded by the invention of the *Congreve* or lucifer match—a beautifully simple, economic, and efficient contrivance.

II. *Materials employed in its Production.*

Best Norwegian deals, (*a*) sulphur, (*b*) phosphorus, chlorate of potash, and (*c*) saltpetre.

a. Sulphur.—A solid, yellow body, brittle and very inflammable; imported from Sicily and Naples. This is now often dispensed with.

b. Phosphorus.—A pale, amber-coloured substance, resembling wax; obtained by chemical processes from various substances. It is remarkably inflammable, being gradually consumed when exposed to the air; luminous in the dark. Preserved in water. Poisonous.

c. Saltpetre.—Obtained from Spain, Russia, Hungary, Persia, India, Java, &c.; generally substituted for chlorate of potash—it prevents the detonation attendant on the ignition of the earlier matches.

III. *Process of the Manufacture.*

Planks cut into *blocks*—each eleven inches wide, four and a half long, and three thick; a single block divided into a hundred *slices*—each slice into thirty-one *splints*—each splint into two *matches*; the number of matches produced from each block is, therefore, $(100 \times 31 \times 2)$ six thousand two hundred. These minute splints are made into bundles of eighteen hundred each; *both ends* dipped into a mixture of *phosphorus*, four parts, *nitre*, ten parts, *fine glue*, six parts, *ochre*, five parts, and *smalt*, two parts, spread upon a slab heated by steam; dried in a hot room. The fumes which rise from this mixture are very hurtful—the work-people suffer greatly. The splints are next cut with a knife fixed to a block, by little children. Packed in boxes and cases. About two hundred thousand cut and two thousand boxes filled daily by a single boy. Three halfpence is paid for cutting and filling a gross of boxes.

IV. *Localities of the Factories.*

Large and important factories are found all over the country, the carriage of the article being

declined by the railway companies; why? The manufacture extends over the world — “from the Black Sea to Sweden, and throughout the United States and Central America.” Germany exports large quantities as “toys.” At Dixon’s factory, near Manchester, the largest in England, from six to nine millions are produced daily. Price, when first made, a guinea a box, afterwards sold for five shillings. Compare this with the present price; why the difference?

V. *Lessons.*

Draw from the children (1) the care required to prevent accidents in the use of these articles; (2) the importance of scientific discoveries in the increase of domestic comfort and convenience; (3) the advantages arising from a division of labour.

LESSON XLIV.—PAPER.

I. *Appearance, Qualities, &c.*

INTRODUCE the lesson by questioning out how we communicate our thoughts and wishes to distant friends; how we obtain much of our knowledge; the necessity of *writing materials* — in ancient times supplied by leaves, bark of trees, skins of animals, wax, metal plates, flat stones, linen-rolls, papyrus (bark of a rush), parchment (the skin of the calf); some of these still used, the last-named chiefly for legal documents. *Paper* generally substituted; manufacture discovered some six centuries since. Exhibit specimens and elicit:—produced from vegetable substances; smooth; more or less porous; of various colours and thicknesses, &c.

II. *Raw Material.*

The raw material chiefly consists of old cotton or linen rags (nettles, straw, saw-dust, thistles, peat, hop-bine, &c. occasionally substituted ;—if possible, show specimens of such papers); peculiarly adapted — previously cleaned from refuse by manufacture into woven fabrics, this expense being paid by the purchasers of articles of dress; no competition for worn-out garments, cotton or linen ; why ? not used in any other manufacture. Produced in all civilised countries ; no expense of production ; gathered by pedlars and store-keepers. Many rags procured in England—old garments ; imported from the centre and north of Germany—twelve thousand bales (one thousand five hundred tons) exported to the British Isles from Hamburg in the first six months of 1856. South Germany, Hungary (Trieste), and Italy (Leghorn) send large quantities—chiefly linen. Russia, France, Belgium, and Spain prohibit the export. The refuse of flax and cotton manufactories is also bought for fine paper—old rope, bagging, &c. for coarser paper.

Straw somewhat extensively employed now ; about sixteen tons of paper made from it weekly ; cheaper than ordinary paper. The raw material both inexpensive and plentiful.

III. *Process of Manufacture.*

Rags sorted by women according to their fineness ; seams removed ; dusted in a large circular sieve ; removed to a trough or cistern through which clear water constantly flows, and torn by cylinders set with iron teeth revolving at the bottom with great rapidity ; cleansed from all impurities and reduced to a fine pulp (the *substance* of paper) ; next placed in a boiler of hot water ; formed

upon moulds composed of interlaced wires (draw an outline upon the black-board); water and superfluous pulp drained off; sheets placed on soft felt*—paper and felt *alternately* in piles; why? Pressed; paper removed; very porous; dipped in a kind of glue, called *size* (hence difference between writing and blotting papers—sized and unsized); pressed—rendered smooth and glossy; made up into *reams*—how many quires? how many sheets to a quire? Sold by stationers. Mills spread over the country—first established, in the reign of Elizabeth, at Dartford; many mills now in the neighbourhood of High Wycombe and Great Marlow.

IV. Results

Many descriptions of paper; applied to a variety of useful purposes—*e. g.*, for books, newspapers, magazines; writing papers—note, letter, foolscap, -draft, &c.; packing and wrapping up goods—brown, grey, whity-brown; covering walls—paper hangings.

Papier-Maché.—Shreds of paper softened, pressed into moulds, dried, japanned, painted, gilded, and polished; produces light, tough, and durable ornaments—*e. g.*, tables, work-boxes, trays, dressing-cases, chairs, &c.

Recapitulate the whole lesson, and give the following for dictation:—

The Paper-Makers' Song.

" 'Tis we that bring riches, 'tis we that bring fame,
Give the banker his notes, and the author his name;
Provide for the future, past ages recall,
Make books for the learned, and letters for all!
But who that beheld us receiving the stuff,
So foul and so tattered, so worn and so rough,

* The process differs slightly in *machine-made* paper.

Could think of the changes our magic can teach,
When we sort, and we dust, and we boil, and we bleach ?
The dark we make white, and the foul we make clean,
And the rags of the beggar we fit for the Queen ;
And the pulp must be taught, ere we work it, to flow
As soft as sea-foam, and as pure as the snow.
From the vat to the cistern, from thence to the wire,
That the pulp may grow firm, and the water retire ;
And still, as it moves in continuous length,
It loses in weight, and increases in strength :
Then o'er the first roller, to dry and to drain,
Then over the second, and under again :
That the damp of the vat it may learn to forget,
It must roll o'er the hot metal cylinder yet ;
Thence passing still onwards, its toil it completes,
Shaped out by the cutting machine into sheets ;
Forthwith we can sort it, as best may beseem,
For the warehouse or shop, in the quire or the ream.
We may learn (who sit watching from morning to night
How foul are our rags, and our paper how white),
When we meet with an evil, how inbred soe'er,
To try and improve it, and never despair !"— NEALE.

LESSON XLV. — SILK MANUFACTURE.

I. *The Raw Material.*

RAW silk obtained from the cocoons ; the chrysalis is previously destroyed by heat ; "floss," the outer covering, removed ; cocoons then placed in hot water ; threads wound upon reels — tied into skeins — packed in hanks. Imported chiefly from China, Italy, France, and India. Of a bright yellow colour : —

"As yellow as furze on a mountain-fell
And soft as a robin's nest."

II. *Process of Manufacture.*

The process of manufacture is called "silk-throwing;"—it includes (1) winding, (2) spinning and twisting, (3) cleaning, and (4) weaving. Work-people (men, women, and children), called "throwsters."

1. *Winding*.—Each reel extended on a sexagonal wheel called a "swift"—wound from it upon "bobbins."

2. *Spinning and twisting*.—Sorted according to fineness, and twisted in passing from *horizontal* reels to *upright* bobbins (illustrate this).

3. *Cleaning*.—Silk boiled for several hours in water with soap; gum removed; silk rendered soft and glossy.

4. *Weaving*.—Woven in the loom; threads of different names,—the long, the "warp"—the cross, the "woof" or "weft."

To prepare it for this last process, it is dyed or bleached; original colour, yellow—*white* produced by bleaching, *coloured*, by dyeing. The workmen are thus enabled to produce fabrics of great beauty.

"Weave brothers, weave, weave and throw
The shuttle athwart the loom;
Come, show us how quickly your flowers grow,
That have beauty but no perfume;
Come, show us the rose with a hundred dyes,
The lily that hath no spot,
The violet blue as the lofty skies,
And the little forget-me-not."

III. *Localities engaged in the Trade.*

Compare it with other manufactures; why less concentrated than that of cotton or woollen? Among the towns at home engaged in the *general*

manufacture are :—Macclesfield, Derby, Norwich, London (Spitalfields and Bethnal Green), Stockport, Manchester ; Dublin ; Glasgow. Abroad—Lyons, Florence, Leghorn, Genoa, Constantinople, Damascus, Aleppo, Shiraz, and Utrecht. Particular branches of the trade are pursued in different districts ; *e. g.* :—

a. Ribbons.—Coventry, Congleton, Macclesfield, Spitalfields.

Coventry is especially noted for the beauty and elegance of its ribbons.

“ Long live the men of Coventry ! His eyes are hard to
please
Who will not own, that out and out, they beat the
Lyonnese.”

b. Crape.—Norfolk, Suffolk, Essex, Somersetshire.

c. Handkerchiefs.—Paisley, Manchester, Macclesfield, Glasgow.

d. Poplins.—Ireland, Manchester, Derby.

e. Gloves and Stockings.—Derby, Northampton, Nottingham, Leicester.

f. Shawls.—Paisley, Norwich, Edinburgh.

g. Velvet.—Spitalfields ; Genoa and Utrecht.

English silk goods are exported most extensively to the New World—British America and the United States.

LESSON XLVI.—SOAP.

I. *Description of Appearance, &c.*

ELICIT from the children some such particulars as the following :—that it is white, brown, yellow, or

mottled; hard or soft; greasy; solid; an artificial substance; soluble.

II. *Composition.*

A combination of tallow, oil, and alkali (soda or potash). Alkali possesses great cleansing power; requires careful using; mixed with grease to prevent injury. Earliest made was soft-soap—composed of fish-oil, tallow, and potash; hard, made of fatty matter (animal or vegetable) and soda. Proportion of each substance—fatty matter sixty-three parts, alkali six and a half, water thirty and a half.

III. *Raw Materials and Countries supplying them.*

Notice next the sources whence we obtain these articles:—

1. *Tallow.*—From Russia (nineteen twentieths of our supply derived from that country), Australia, Brazil, and Buenos Ayres. Large home supply also.

2. *Palm-oil.*—Chiefly from Africa, between five degrees north and three south latitude; Brazil; and India. Forty thousand tons imported annually, valued at a million sterling. Extracted from nuts of the shape and size of pullets' eggs; grow in clusters of five or six hundred; smooth; yellow or red; contain a thick oily fungus, with a small stone in the centre; exposed, after gathering, to the sun for several days; bruised; crushed into a paste; placed in boiling water; a large quantity of orange-coloured oil gathers on the top; nearly tasteless; powerful odour; hardens in cooling to the consistence of butter. Notice the effect this trade has had on slavery in Africa—the labour of the negro is found more profitable than his sale.

3. *Soda*.—Manufactured from salt, formerly from sea-weed ; kelp then eleven pounds, now only eleven shillings, per ton ; improved method discovered by the French. Called also *Natron* ; obtained from lakes in Egypt ; taken by divers from the bottom of Lake Maracaybo (South America). Hungary, Spain, La Plata, and the Canaries supply it.

4. *Potash*.—Ashes of burnt wood washed ; potash melts ; ashes strained off ; potash found at the bottom of the water. Exported by Russia, Canada, and the northern parts of the United States.

IV. *Manufacture—Process and Results.*

The manufacture not confined to any particular districts—spread throughout the kingdom ; generally made in conjunction with candles, in almost all large towns. The tallow and oil boiled in water in which the soda has been previously dissolved ; frequently stirred ; alkali and grease gradually combine—produce *soap*. Poured into boxes ; when firm, the boxes are removed ; soap cut into “slices” and “bars” by means of wires. This process is common to all soaps. Sold under many different names—*e. g.*, *white or curd*—made of the best materials (best tallow) ; *yellow*—greater quantity of palm-oil ; *mottled*—alkali and water poured over it while cooling—causes the dark veins ; *fancy soaps*—very varied—chiefly for the toilet, as honey, glycerine, &c.—generally made up by perfumers. *Castile soap*, imported from Spain and Marseilles.

V. *Uses.*

Useful for cleansing our clothes, houses, and persons : dwell on the duty of cleanliness, and its effect upon health. Extensively employed in manufactures.

LESSON XLVII.

THE RISE, PROGRESS, AND HISTORY OF THE WOOLLEN MANUFACTURE IN ENGLAND.

I. *Origin of the Manufacture.*

DRAW from the children the necessity of clothing for animals, *natural* or *artificial* ; the latter required by man ; why ? The quality and quantity determined by the climate and state of civilisation ; procured from either the vegetable or animal world ; among savages of the slightest and rudest kind — generally the *skins of beasts*, the shepherd taking his sheep's skins, the hunter those of his prey — easily adapted for a covering. Adam and Eve had "coats of skins" (Gen. iii. 21), and saints wandered in "sheep-skins and goat-skins" (Heb. xi. 37) ; some Europeans (Russians, Lapps, Pyrenean shepherds, &c.) yet dress in them. The hard, dry skins, unpleasant ; the natural *felting* of wool would suggest improvements ; *felt* produced by beating and pressure ; spinning and weaving discovered very early (*vide* Job, xxxi. 19, 20) ; coarse cloth made ; *shearing* the living substituted for *flaying* the dead animal — more economical — the clothing produced more comfortable, agreeable, and healthful.

II. *Introduction and History of the Art in England.*

Trace out the condition of the manufacture under each line of sovereigns : —

a. *Under the Romans and Saxons.*—Notice the dress of the ancient Britons—chiefly undressed skins, "a mantle which descended to the knee, made of the hide of a brindled cow with the hair

worn outwards ;” woollen manufacture introduced by the Romans with other arts ; woollen garments little used till long after the Conquest. Spinning known and practised by the Saxons ; the occupation of queens, princesses, and noble ladies—*e. g.*, Osburga and her daughters ; hence derivation of “spinster”—the legal name for an unmarried female.

b. Time of the Normans (11th and 12th centuries).—English less clever than their continental neighbours. Flemings brought over (whence ?) by the Conqueror, and settled at Carlisle ; removed to Wales by Henry I. They laid the foundation of the general manufacture. “Cloth Fair,” near Smithfield, established by Henry II. Why likely to become a settled manufacture in this country ?

c. Under the Plantagenets (14th century).—Raw wool then the staple of England ; exported to Italy, Holland, and Belgium. The queen’s jewels, valued at 2500*l.*, redeemed with wool. Notice also the *woolsack* of the House of Lords. Edward III. (through his queen Philippa, daughter of the Count of Hainault) invited many more Flemings (among them were John Kempe and Thos. *Blanket*) into England ; scattered them throughout the country ; forbade the export of wool, and the import of foreign cloth.

d. Under the Tudors (16th century).—The trade depressed, but slightly revived by the invention of the *spinning-wheel* in the reign of Henry VIII. ; called also the “wool-wheel ;” great improvement upon the distaff and spindle, which it superseded. In the time of Elizabeth an extensive immigration of Flemish refugees (persecution of the Duke of Alva and Philip of Spain) introduced superior ma-

chinery ; possessed greater skill ; better and cheaper fabrics produced.

e. House of Orange (17th century).—Manufacture firmly established under William III. ; dyeing and dressing first done in England.

f. House of Brunswick (18th century).—Shaken by the first cotton trade (1780) ; retarded awhile, afterwards improved and extended ; machinery (spinning-jenny, power-loom, &c.) and steam power substituted for the hand-loom and manual labour ; cost lowered ; greater demand.

III. *Present Condition.*

Lead the children to see its vast importance by considering—(1) the localities where carried on, (2) the people engaged, and (3) the results produced.

1. Trade located chiefly in two districts—the West Riding of Yorkshire and the West of England (Gloucestershire, Wiltshire, Somersetshire). Both *physically* adapted ; how ? near seaports (raw material easily obtained), water, coal, and iron plentiful.

2. Numerous large, populous towns supported by it ; in the former district, Leeds, Bradford, Halifax, Huddersfield, Dewsbury, Wakefield, Keighley, and many villages produce (generally) coarse cloth ; in the latter, Stroud, Great Bradford, Frome, Trowbridge, Melksham, Chippenham, Westbury, “West of England cloth”—of finer texture—why ? finer wools grown in southern counties.

Contrast the former *domestic* manufacture with the present *factory* system of labour ; when it was spread over the whole country, the wives and children of the farmers prepared the yarn, which was woven into “homespun” cloth by itinerant weavers,—when —

“ The dame was wont
To set her wheel before the cottage front,
And o'er her spectacles would often peer
To view our gambols and our boyish geer ;
Still as she look'd the wheel kept turning round
With its beloved monotony of sound.”

Gives employment to four hundred thousand people—four times the number engaged in the manufacture thirty years ago. Annual value of goods, twenty-two millions sterling. Some of the Yorkshire manufacturers use four hundred tons of olive oil annually in the preparation of their cloths and yarns.

3. Results very varied :—raw wool imported from all quarters ; English woollen goods (cloths, flannels, blankets, merinos, stuffs, tweeds, damasks, &c.) exported over the whole world, especially to Germany, Russia, and the United States ;—*e. g.*, in the late war (1856) France expended more than a million sterling in English rugs, cloths, and blankets, for her army.

IV. *Lessons.*

Draw from the children or lead them to see—

a. That kindness and generosity are never wasted ; the shelter and protection afforded the persecuted and suffering refugees of the sixteenth century repaid by the benefits we derive from their skill.

b. The importance of discoveries in manufactures in contributing to our domestic comfort ; “broad-cloth” formerly worn only by the rich—the cheapest, eight or ten shillings per yard ; poor men were clothed in “second-hand” garments ; *now*, good woollen cloth is within the reach of all at five shillings a yard—the cheapest about two shillings, the dearest, ten.

MISCELLANEOUS.

LESSON XLVIII.—AVALANCHES.

THIS lesson might follow one on the geography of Switzerland.

I. Formation and Localities.

Consist of masses of snow or ice ; descend from elevated regions ; frequent upon all lofty mountains—*e.g.*, Alps, Pyrenees, Dofrine, &c.

II. Description of the various Kinds.

Four kinds—(a) *drift*, (b) *sliding*, (c) *creeping*, (d) *ice or glacier*.

a. *Drift*.—Formed of loose or drift snow ; originate at a great elevation.

“ The avalanche—the thunder-bolt of snow.”

Generally happen in winter ; descend unexpectedly without apparent cause—probably started by the wind ; increase on the way. Air compressed by their velocity—destroys houses, trees, &c. This kind rarest of the four, but most destructive. Some descend a distance of ten miles.

b. *Sliding*.—More frequent ; less destructive, yet, from their number, cause greater damage. Sheets of frozen snow ; formed on steep declivities and middle regions of mountains ; fall in spring ; cover meadows and fields ; several summers before they melt. Very common in Norway.

c. *Creeping*.—Called so from their slow, creeping approach ; formed in a similar manner to (b)

sliding — on more gentle slopes ; small in volume ; very frequent ; little damage. Occur in spring.

d. Ice or glacier. — Masses of glacier detached in their descent ; occur in summer ; generally fall upon uninhabited places ; less fatal effects.

“ Mountains have fallen,
Leaving a gap in the clouds, and filling up
The valleys with destruction's splinters.”

III. *Instances of Effects.*

Notice a few instances of their effects ; *e.g.* :—

1. In 1749: whole village of Bueras (Switzerland) buried or removed by a *sliding* avalanche, in the night ; noiseless, the inhabitants unable to account for the continued darkness. One hundred persons dug out—sixty alive.

2. In 1806: a forest transplanted to the opposite side of the valley ; a fir-tree was removed to the roof of the parsonage.

3. Sixty deer were found dead in a narrow valley in Norway ; how were they killed ?

4. At Radna, in 1819: a glacier avalanche carried beams of houses a mile away ; raised and removed millstones ; broke down the church spire, which was of stone.

“ Oft rushing sudden from the loaded cliffs,
Mountains of snow their gathering terrors roll
From steep to steep ; loud-thundering they come ;
A wintry waste in dire confusion all ;
And herds, and flocks, and travellers, and swains,
And sometimes whole brigades of marching troops
Or hamlets sleeping in the dead of night,
Are deep beneath the smothering ruin whelm'd.”

LESSON XLIX.—THE BAROMETER.

I. *Its Principle.*

A COLUMN of air is equal to one of water thirty-three feet high—or another of quick-silver of thirty inches. The pressure of the atmosphere equals the pressure of a layer of water thirty-three feet deep, or a layer of mercury thirty inches thick—hence they counter-balance; change in the one will produce a proportionate change in the other. A barometer might be constructed of *either* liquid—mercury the more convenient. Name derived from *baros*, “weight,” and *metron*, “a measure;” a measure of the weight of the atmosphere—sometimes called a weather-glass.

II. (1) *Description* and (2) *Construction.*

1. A glass tube (T*) filled with mercury; the open end placed in a vessel of the same fluid; a scale, graduated in inches and tenths of inches, placed behind to measure the height of the mercury.

2. Take a glass tube thirty-four inches long; fill with quicksilver; cover the open end with a finger; plunge into a vessel (V); withdraw the finger without admitting the air; the metal descends, vibrates, and finally rests at about twenty-nine or thirty inches above the surface (S). If to be moved about, the cup (V) must be closed, the tube fixed, and the whole placed in a wooden or metal case.

Other forms of the instrument known by different

* Draw a diagram on the black-board.

names, as (a) the *wheel* barometer and (b) the *marine* barometer.

a. The wheel barometer similar to the last. A tube (τ^*) with a short leg (L) filled with mercury; a piece of glass or an iron ball floats at G, attached to a silken cord passing over a pulley (P), to which is fixed an index or hand working around a circular plate graduated with "Rain," "Fair," "Dry," "Changeable," &c. Any movement of the glass at G indicated by a movement of the hand; thus all changes in the weight of the air are measured.

b. In the marine instrument—the tube contracted to a very narrow bore in one part, to prevent the sudden rising and falling of the mercury which the motion of the ship would occasion.

III. *Uses, &c.*

The space A is a vacuum (the Torricellian vacuum, first observed by Torricelli)—a space entirely empty of every substance; obtained by filling the tube with mercury, thereby excluding all air; the mercury sustained in the tube by atmospheric pressure.† Medium altitude on the surface of the earth, twenty-nine inches; affected by the constantly fluctuating state of the atmosphere; therefore useful as a

(1) Weather-glass to farmers, travellers, and sailors; the air being heaviest in *clear* weather, the mercury *rises*; in dull *damp* weather, air, lighter, mercury *falls*. . A *low* glass indicates rain and foul weather.

* Draw a diagram on the black-board.

† If a barometer be a bad one, on swinging it in a dark room you see flashes of light, which denote the presence of vapour in the tube—not a perfect vacuum. In a good instrument the mercury beats heavily against the tube, proving the space a vacuum.

"The hollow winds begin to blow,
The clouds look black, *the glass is low* ;
'Twill surely rain, I see with sorrow
Our jaunt must be put off to-morrow."

Compare this with the common error, that in foggy weather the air is heaviest, and that the heavy air presses down the smoke, vapours, &c. Disproved by the principle that the lighter a fluid is, the deeper any heavy substance will sink in it.

(2.) To scientific men, it supplies a simple and accurate method of measuring heights, mountains, elevation of balloons, &c. Mercury falls in rising above the surface—*e.g.*, in carrying a barometer from the level of the Thames to the top of St. Paul's, the mercury falls half an inch, showing an ascent of about five hundred feet—on the summit of Mont Blanc (fifteen thousand eight hundred feet) it sinks to sixteen inches. M. du Lac, the highest aeronaut, found his barometer stand at twelve inches, when he reached an elevation of twenty-two thousand feet.

(3.) Indicates the approach of storms ; greatly depressed before tempests, winds, hurricanes, &c. ; known to sink a hundred degrees in a few hours before a violent storm. During the Lisbon earthquake the mercury fell so low in the barometer, even in Great Britain, as to disappear from the uncovered portion.

(4.) Of great use in coal mines ; by it the presence of fire-damp is discovered ; in a heavy atmosphere the fire-damp is pressed into the crevices and cracks, and the place is safe—in a lighter, it expands and explodes when it comes in contact with flame.

Note.—"It was in a southern latitude, the sun

had just set with a placid appearance, closing a beautiful afternoon, and the usual mirth of the evening watch was proceeding, when the captain's order came to prepare with all haste for a storm. The barometer had begun to fall with alarming rapidity; and yet the oldest sailors had not perceived even a threatening in the sky, and were surprised at the extent and hurry of the preparations; but the required measures were not completed, when a more dreadful hurricane burst upon them than the most experienced had ever witnessed. Nothing could withstand it; the sails, already furled and closely bound to the yards, were riven away in tatters; even the bare yards and masts were in great part disabled; and at one time the whole rigging had nearly fallen by the board. Such, for a few hours, was the mingled roar of the hurricane above, of the waves around, and of the incessant peals of thunder, that no human voice could be heard, and, amidst the general consternation, even the trumpet sounded in vain. In that awful night, but for that little tube of mercury which had given warning, neither the strength of the noble ship, nor the skill and energy of the commander, would have saved one man to tell the tale."—*Dr. Arnott's Elements of Physics.*

LESSON L.—DEW.

I. *Formation.*

SELECT a suitable day, and direct the attention of the children to the dim appearance of the school-windows, and draw from them the reason. The

air filled with vapour ; the quantity in proportion to its temperature ; when it comes in contact with any cooler substance, it deposits a part of this moisture,—thus, the glass being *cooler* than the air of the room, *condenses* the vapour that comes in contact with it.

Illustration.—A glass filled with cold water, or a bottle of wine brought from a cold cellar into a hot room, is soon covered with moisture.

During the day, plants, the earth, and other objects *absorb* heat from the sun—when he sets they *radiate*, or give off a portion of it, and so cool down ; the air in contact is cooled, becomes less solvent, and deposits some of its moisture in the form of *dew*. Dew does not *descend* as rain, (as was formerly thought) ; it is found on the *under* and *side* surfaces of plants and objects which nothing rising or falling could reach ; forms into globules of extreme beauty—“dewdrops” clear and sparkling, emblems of beauty and purity. “Resting in luminous beads upon the down of leaves, pendent from the finest blades, or threaded upon the floating lines of gossamer, its orient pearl varies in size from the diameter of a small pea to the most minute atom that can be imagined to exist.” When frozen, dew is changed into hoar-frost—the ice of dew :—

“ Then fields with glist'ning dew-drops bright
Seem changed to sheets of silver white.”

II. *Deposition.*

The deposition of dew is very irregular ; affected by (1) the state of the weather, (2) the nature of the object exposed, and (3) the locality.

1. Cloudless nights after hot days most favour-

able to the deposition ; the heat, radiated, ascends at once to the higher regions, and the surface of the earth is rapidly cooled. What follows ? Little or none on *cloudy* nights ; the radiated heat is reflected back to the earth by the clouds ; effect—surface not cooled sufficiently.

Illustration.—Gardeners protect tender plants and trees by means of awnings ; these act in the same manner as the clouds, and return the heat.

Winds are generally unfavourable ; in Egypt a *north* wind (from the Mediterranean) brings much ; from the *south*, very little ; why ? What wind in England is most favourable ? why the *west* ? Copiously deposited in Great Britain during spring and autumn. Annual deposition in England equals five inches.

2. Some substances part with their heat less rapidly than others, as water, rocks, stones, and metals—these therefore receive little dew ; grass, low plants, &c., cool quickly, and so receive much more. Hence gravel walks, stones, buildings and water receive little, while the surrounding vegetation is covered.

Experiments.—*a.* Take equal quantities of wool of a given weight, place them respectively on gravel, grass, and glass ; weigh them in the morning ; the increase of weight will show the amount of moisture deposited on each.

b. Place thermometers upon a garden walk and upon grass-turf ; that upon the latter will be found some sixteen degrees lower than the former.

3. Dew is most plentiful in Western Asia and other places where the rains are *periodical* ; to them it is a substitute for rain ; of great importance in nourishing vegetation and protecting it from the excessive heat—*e. g.*, very copious in Palestine :

"Our tents were as wet with dew as if it had rained all night."

III. *Uses.*

In France it is employed to split blocks of stone into horizontal layers for mill-stones: wooden wedges introduced; these absorb the dew, expand, and split the stones.

Of great utility in affording nourishment to plants and vegetables, which, without it, would suffer from the drought and heat.

Notice also the beauty of early morning, when—

"Morning shines
Serene, in all her dewy beauty bright;
And hung on every spray, on every blade
Of grass, the myriad dew-drops twinkle round."

IV. *Scriptural and Liturgical References.*

Frequent allusions to it, on account of its importance, in Holy Scripture; *e.g.*:—

a. Moses, in blessing Joseph's inheritance, numbers it with "the precious things of heaven." (Deut. xxxiii. 13.)

b. The Psalmist compares brotherly love to "the dew of Hermon." (Ps. cxxxiii. 3.)

c. David mentions its absence as a curse. (2 Sam. i. 21.)

d. In the Collect for clergy and people, it typifies *grace*: "The dew of Thy blessing."

"The dew of heaven is like Thy grace,
It steals in silence down;
But where it lights the favour'd place
By richest fruits is known."

LESSON LI.—GRAVITATION.

I. *The Force of Gravity.*

ETYMOLOGY—Latin, *gravis*, “heavy, weighty ;” called also the force of gravity—the force by which particles of matter mutually attract each other—the force by which all things are drawn towards the centre of the earth. Universal ; all things subject to its influence ; acts in all directions ; its power in proportion to the mass or quantity of matter contained in the attracting body ; some bodies of equal size contain more matter than others—*e. g.*, pieces of *lead* and *cork*—to exert an *equal* attraction, the latter must be about *twelve* times larger than the former, as it contains about twelve times less matter than a piece of lead of equal dimensions. Distance likewise determines the force of gravity ; it is inversely as the squares of the distances between the two bodies — *e. g.* : —

If at 2 ft. distance, it = 4 lbs., then at 4 ft. it will be but 1 lb. ; or, if 3 lbs. at 6 ft., then 27 lbs. at 2 ft.

II. *Examples and Illustrations.*

Draw from the children examples of this force, as seen daily around us, and lead them to others ; *e. g.* : —

1. Unsupported substances fall to the ground ; the earth exerts the greatest force, and attracts them towards its centre.

2. Small bodies floating upon water are drawn together into heaps or clusters.

3. A plummet suspended over a precipice is drawn towards the rock.

4. Leaden balls suspended by wires—the smaller attracted by the larger when brought near each other.

5. Two cannon-balls hung near together by long ropes exert mutual attraction, both ropes being drawn out of the perpendicular.

6. The sun attracts the earth — the earth, the moon—the moon and sun, the waters of the earth, producing the tides ; accounts for the revolution of the earth, planets and their satellites ; for —

“ Attraction is the hidden force
On which Creation’s law depends.”

7. It is gravity which gives weight to bodies. Discovered by Sir Isaac Newton by the falling of an apple to the ground in his garden at Woolsthorpe, in 1666.

III. *Apparent Contradictions.*

Notice that some substances appear not to gravitate ; *e. g.*:—

a. Smoke, steam, and balloons *rise* in a direction opposite to the force of gravity. They are forced upward by the pressure of the air, being lighter, volume for volume,—as cork, wood, or oil rise through water, and stones, lead, or iron through quicksilver.

b. Birds rise in the air ; they are animate ; supported by the action of their wings ; descend like stones when shot, their *specific gravity* being greater than that of air.

Note.—“The intensity of gravitation varies from local causes as well as from the form of the earth ; it is feeble at Bordeaux, and increases to Clermont, Ferrand, Milan, and Padua,—this increase being probably caused by dense masses underground.”

IV. *Specific Gravity.*

Specific gravity: this is the proportion of the weight of a body to the weight of an equal portion of another substance of a *chosen standard*, which is distilled water at the temperature of 60° of Fah-

renheit — *e. g.*, if the specific gravity of a mineral equal *three*, the weight of any volume of it equals three times that of the same volume of distilled water. In comparing specific gravities, equal *bulks* must be taken.

To find the specific gravity, “weigh the body in air, in the usual way, and then in water, — in the latter case it will be lighter; *subtract* the weight of the body in water from the weight of it in air, the remainder will give the weight of an equal volume of water; state the following proportion to complete the process, — As the weight of the water is to the weight of the solid, so is 1000 to the number expressing the specific gravity of the solid — *e. g.*, if a body weigh in the air 960 grains, and in water 650; then, $960 - 650 = 310$ grains; then, — As $310 : 960 :: 1000 : 3097$ (nearly), the specific gravity of the solid.” The specific gravity of *liquids* is readily discovered by the *hydrometer*.

V. Lesson.

A consideration of this wonderful, invisible force leads us to admire the power of Almighty God, “Who appointed the sun his place, launched the planets in the depths, obedient to the law which has preserved the family compact originally established unbroken through the long series of ages :” —

“Who plann’d, and built, and still upholds, a world
All clothed with beauty for rebellious man.”

LESSON LII. — ICE.

I. Formation of Ice.

If possible place before the children a lump of ice, and elicit how it is produced. Heat abstracted

from the water till its temperature is reduced to *thirty-two degrees*, the freezing-point of water ; it then becomes *solid*—formed into hail, snow, or ice :—

“A crystal pavement, by the breath of Heaven
Cemented firm.”

A bottle filled with water, and securely corked, is shattered while its contents are freezing ; the effect of *expansion* ; nine cubic inches of water become ten of ice ; why ? the fluid particles of water fit closer than the solid crystals of ice ; hence:—

a. On melting a block of ice, a much smaller bulk of water is left.

b. Glass and earthen vessels are often broken in frosty weather by the freezing of their contents.

c. Tiles, slates, bricks, rocks, &c., are occasionally cracked by the frost ; their moisture frozen, expanded, and the solid split.

d. Water-pipes frequently burst from the same cause. Notice the effect of frost upon rocks, reducing them to sand.

II. *Waters affected by Frost.*

Show that all waters are not equally affected by frost. *Shallow* water freezes sooner than *deep* ; why ? the *whole* body must be reduced to the temperature of the freezing-point before it begins to congeal ; a deep bed takes longer to cool than a shallow one. The surface first covered with ice, which floats and thickens as the cold continues,—the heat of the water passing off through its pores ; hence, a frost is *warmer* than a thaw. Notice that some waters rarely freeze ; e. g. :—

1. *Sea-water*.—The mass being so great, requires a long time to cool ; tides also prevent it, but chiefly its saline properties, for salt freezes only at a much

lower temperature. Common sea-water congeals at about twenty-seven degrees.

2. *Running water*.—The motion of the water in rivers and brooks retards the freezing process; yet occasionally their surfaces are covered with a rough, uneven coating of ice.

3. *Lakes*.—Generally of great depth; frequently supplied at the bottom by springs; these supplies prevent the necessary reduction of the temperature.

III.* *The Frozen Regions.*

In high latitudes, in the vicinity of the Poles, ice is perpetual; the Arctic and Antarctic called the *Frozen Oceans*; these parts of the earth the *Frigid* (from *frigere*, "to be cold") Zones. Here, "the surface of the ocean is converted into one solid mass—every tree fringed—every stream stopped; the severity of the cold appears in icicles pendent from the eyelashes of every Russian boor and the conversion of his beard into a lump of ice, from the congelation of the vapour of his breath." Thus are formed—(a) icebergs, (b) icefields or floes, and, at great altitudes, (c) glaciers.

a. *Icebergs*.—Masses of ice of immense size; sometimes two miles in circumference and two hundred feet high:—

"Icebergs vast,
With heads all crown'd with snow,
Whose green roots sleep in the awful deep,
Two hundred fathoms low!"

They are broken from the glaciers of these regions, and carried by the polar currents into the open water of the Atlantic and Southern Oceans; most common

* It may be found convenient to divide these notes into two parts, taking sub-divisions III. and IV. for a separate lesson.

in the latter; why? the ice of the South less hemmed in by land than that of the North Frigid Zone; the climate of the southern hemisphere is said to be affected by the cold they give off on entering a warmer atmosphere. Gradually dissolved. Sometimes reach as low as the Azores and the Cape of Good Hope, Beautiful in appearance; the white part as brilliant as silver, the colours of the other portions as varied and splendid as those of the rainbow. Shapes very irregular; resemble palaces, cathedral towers and pinnacles, castles, obelisks, pyramids, &c. A number seen together appear like a mountainous country. Extremely dangerous to ships.

“Far as our wandering eyes could reach
Uprose their summits clear;—
Like cities on a distant shore
We saw them floating near.
Cathedrals, pinnacles and towers,
And palaces of cold;
Rose-tinted, amber, opal, blue,
Alight with living gold.”

b. Icefields and flocs.—Large sheets of ice detached and borne by the same currents into the temperate regions; sometimes a hundred square miles in extent. Upon one Captain Parry was carried southward faster than he could travel northward. The polar bear and arctic fox are often found upon them. They frequently destroy whalers and merchantmen:—

“On the frozen deep’s repose
’Tis a dark and dreadful hour
When round the ship the icefields close
To chain her with their power.”

c. Glaciers.—Bodies of ice formed in the valleys of mountainous districts. Not confined to the frozen regions; very common in the Alps; occur in the

Pyrenees, Sierra Nevada, Norway, Iceland, Spitzbergen, Greenland, and Tierra del Fuego. Fragments displaced prove very destructive.

IV. Remarkable Frosts.

Notice a few of the winters which have been noted for their severity in our own and neighbouring countries —

“ Winters such as when the birds die
In the deep forests, and the fishes lie
Stiffen'd in the translucent ice.”

1. 1408. — The Danube frozen over; also the Baltic between Denmark and Norway. Vineyards and orchards of France greatly damaged.

2. 1605. — Charles XII. of Sweden crossed the *Little Belt* into Denmark with his whole army, foot and horse, followed by baggage and artillery.

3. 1684. — Trees split by the frost; birds perished; hardy plants killed. Thames frozen over; ice eleven inches thick; coaches driven upon it.

4. 1709. — The *cold winter*. Most rivers and lakes frozen. Men perished; numbers of birds and beasts died. Corn doubled its price, from forty to eighty shillings per quarter.

5. 1716. — Celebrated fair upon the Thames.

V. Uses of Frost and Ice.

Draw from the children a few of the uses of frost and ice; *e. g.*:—

a. Frost of great utility to the husbandman; destroys insects; breaks up the clods of hard and stubborn soils, which crumble into dust after a hard frost, pulverised by expansion.

b. Ice affords healthful and pleasant recreation in winter. In England —

"The *skaters* swiftly skim the pool,
While there the merry children *slide*,
With swinging satchels, freed from school."

Canals and rivers in some countries (*e. g.*, the Netherlands) become the highways; the people, men and women, skate with their goods to market. In Russia artificial ice-mounds are a great amusement. On the Neva, Queen Catherine constructed a splendid palace of ice — "chairs, tables, sofas, fire-places, and a beautiful throne of ice; coloured waters thrown on the walls froze into beautiful wreaths of icy flowers; it appeared to be built of millions of diamonds:"—

"No forest fell
When thou wouldst build, no quarry sent its stores
To enrich thy walls; but thou didst hew the floods,
And make thy marble of the glassy wave."

c. Frost preserves the food of the inhabitants, and the produce of their farms, in very cold countries. Thus, during winter, "in Quebec markets everything was frozen; large pigs stood in their natural position on their rigid limbs, or upright in corners, killed perhaps months before. Frozen masses of beef, sheep, deer, fowls, cod, haddock, and eels long and stiff like walking-sticks, abound on the stalls. Milk was sold by the pound, like lumps of white ice."

d. Ice, an article of food in confectionery. Gathered and stored in ice-houses; exported from North America to the Indies and England; Wenham Lake (Mass.) supplies great quantities. Brought as *ballast*; blocks fitted into the holds of ships, covered with straw, sawdust, and charcoal; why? good non-conductors. Straw frequently used among us for protection against frost.

VI. Lesson.

Admiration of the infinite majesty and power of our Almighty Creator, "Who casteth forth His ice in morsels" (*i. e.*, as hail); Who maketh "the cold north wind to blow and the water is congealed into ice; it abideth upon every gathering together of water, and clotheth the water as with a breast-plate."

LESSON LIII. — INGREDIENTS FOR A PLUM PUDDING.

I. DRAW from the children, and write upon the black-board, the names of the various articles used in making a "Christmas Pudding;" *e. g.*:—

- | | | |
|-------------------------------------|---------------|---------------|
| (a) Flour. | Bread-crumbs. | (f) Nutmeg. |
| (b) Eggs. | (c) Salt. | (g) Sugar. |
| Milk. | (d) Cinnamon. | (h) Currants. |
| Suet. | (e) Ginger. | (i) Raisins. |
| (j) Orange, lemon, and citron peel. | | |

II. Elicit a description of each article in detail, and give a few particulars respecting its cultivation, preparation, and production.

a. Flour. — Trace it from the field to the mill, and through its various stages. Large quantities required by our population; partly supplied from abroad; imported from Russia, Prussia, Germany, and America.

b. Eggs. — Supplied from the poultry yard. Numbers imported from Ireland, Belgium, and France, especially from the farms in the vicinity of Caen, Harfleur, and Cherbourg. Ireland alone

exports upwards of fifty millions annually, valued at one hundred and twenty thousand pounds. London imports one hundred and fifty millions from Ireland, Scotland, and abroad, yearly.

c. Salt.—Procured from mines, and, by evaporation, from salt-springs and sea water. Nantwich, Droitwich and Stoke supply large quantities.

d. Cinnamon.—The *inner bark* of a kind of laurel; attains the height of nine feet; evergreen, with delicate white flowers. Name derived from two Malay words, meaning *sweet-wood*. When three years old, the bark is peeled off from the *branches* (why not from the trunk also?) by means of knives; dried in the sun; curls into "*quills*," the smaller within the larger; changes colour from green to brown—*cinnamon-brown*; becomes very brittle. Tied into bundles; packed in bales; exported. Grows wild in Ceylon,—where, also, near Columbo, it is cultivated in gardens and plantations. Gathered *twice* in the year; the first, or great harvest, continues from April to July—the second, or little harvest, from November to January. Imported also from Japan.

e. Ginger.—The *root* of a species of rush; odorous and pungent. Grows to the height of two or three feet; bears white and lilac flowers. Native of the East, but also cultivated in the West Indies. Planted in March; roots dug up in the following January; washed in hot water, scraped, and dried—*black ginger*; *white*, peeled without scalding; young roots called *green ginger*—a pleasant preserve.

f. Nutmeg.—The seed of a tree about the size of an apricot bush; thick, bright green foliage. Fruit similar to an apricot or peach; covered with yellow spots. Pulp bursts when ripe; nut ex-

posed, with a covering of scarlet membrane (*mace*); the woody shell contains the *kernel*, the nutmeg. Gathered; cleansed of the pulp; dried; shells removed; nuts "limed" (dipped in a solution of lime and sea-water; prevents mouldiness and preserves them from insects). The produce of the Spice Islands—Sumatra, Banda, Penang, the Moluccas; Ceylon, and the West Indies.

g. Sugar. — Imported from the East and West Indies, Brazil, &c. Obtained from *sugar canes*; juice expressed by crushing between rollers in mills; boiled and refined. Syrup granulates or crystallises in cooling. Extracted also from the *beet-root* in France, Germany, Belgium, and Russia; from the *maple* in North America.

h. Currants. — "Grapes of Corinth," so called from the locality of cultivation. Little grapes of a beautiful purple colour; produce of small *vines*, generally clipped into the form of *bushes*. Gathered and laid upon cloths to dry in the sun; packed when thoroughly dried. Exported from the Morea, Corfu, Cephalonia, Zante, &c. Morean considered the best; chiefly exported from Patras.

i. Raisins. — Called also plums—dried grapes. Obtained from the vineyards of Spain, Portugal, Italy, Syria, &c. During the vintage, the stems of the bunches intended for raisins are cut partly through, and then left to wither on the branches; afterwards gathered and dried in warm, shady, situations. Packed and exported under various names, as Valencias, Malagas, &c.

j. Orange, lemon, and citron peel. — The thick rind of these fruits boiled and candied in sugar, obtained from the orangeries of Southern Europe, Spain, Portugal, Malta, Sardinia, the Azores, &c.

III.* *Recipe (from the "Family Economist.")*

"Would you make a good pudding, pray mind what you're taught,

Take two pen'orth of *eggs* when they're twelve to the groat,

Six ounces of *bread* (let Mill eat the crust) —

The crumb must be grated as fine as the dust ;

Six ounces of *flour* you may add if you please —

Stir it smooth as a paste with the eggs by degrees ;

Six ounces of *plums*, from the stones you must sort,

Lest they break all your teeth and spoil all your sport ;

Six ounces of *currants*—be sure wash them clean,

And six ounces of *suet* shred fine and stir in ;

Some *lemon* and *citron peel*, and, if you choose,—

Some people prefer it, but others refuse,—

Six ounces of *sugar* won't make it too sweet ;

And some *salt* and some *nutmeg* the whole will complete.

Let it boil for six hours without any flutter,

Nor is it quite finished without melted butter."

LESSON LIV.—THE COMMON PUMP.I. *Its principle.*

QUICKSILVER supported at the height of thirty inches by the pressure of the atmosphere ; water, thirteen and a half times lighter, supported at a greater height ; thirty-three feet ; the two equal — *e. g.*, if a cubic foot of one fluid equal the weight of two cubic feet of another, the air will support a column of the latter at twice the height of the former. *Atmospheric pressure* the principle upon which the common pump is constructed.

Illustrations : (1) a straw-tube, or reed ; (2) the common squirt.

* This may be added when the lesson is given to girls.

II. *Construction.*

A *tube* (a pipe or trunk of a tree), the lower end perforated to admit water and prevent dirt and stones entering, immersed in the water. Fitted with an air-tight stopper, or *piston*, moved up and down by an iron rod, the *handle*; v* and x, two *valves*, or little doors, opening *upwards*; why? The former in the piston, the latter in the trunk.

III. *Action.*

When the pump is inactive, the *valves* close by their own weight; the handle being drawn *down*, the piston is raised, and the air above with it; a vacuum produced under it; this is filled by air rushing through the valve x, which opens and admits it into the pump-box. A few strokes remove the *air*, when *water* rises instead, to destroy the vacuum, and, being lifted by each stroke, it flows out through the *spout*. The valve x closes by the weight of the water above on each *up* stroke of the *handle*, and v is forced open by the upward pressure of the same,—and *vice versâ* on the *down* stroke. This is in reality a *lifting* pump—the water raised by atmospheric pressure and forced out by lifting. Generally only twenty-eight feet long; a perfect vacuum difficult to obtain.

Note.—Valves made of leather, when dry, fit loosely; pump will not work; water poured in moistens the leather; it expands, and the pump will act.

LESSON LV. — PRESSURE OF THE ATMOSPHERE.

INTRODUCE the lesson by some simple experiment; e. g., fill a wine-glass with water, carefully cover

* Mark these upon the diagram, drawn on the black-board.

the surface with a close-fitting piece of paper, invert the glass, and the water and paper are supported by—the *Atmosphere* ; composed of air with clouds and vapours floating in it ; a thin fluid ; elastic (compare with other liquids) ; surrounds the earth similar to an ocean. Extends forty-five miles above the earth ; of great weight ; equal to fifteen pounds on every square inch of surface ; upon all things animate and inanimate, on all sides and in every direction.

Illustrations.—*a.* The pressure of the whole atmosphere upon the earth is equivalent to the weight of a globe of lead sixty-six miles in diameter—or it equals five thousand millions of millions of tons.

b. A man of moderate stature is subject to a pressure of fourteen tons, or about thirty-two thousand pounds, his body containing two thousand square inches. How is this ascertained ?

Heaviest nearest the earth ; rarefied higher up—*e. g.*, at three miles' elevation it is only one half the density of the air at the earth's surface, at six miles a fourth, and at fifteen only one thirtieth.

We are insensible of this weight ; why ? all fluids press equally on every side ; the opposite pressures counteract each other.

Experiments and Illustrations.

1. The hand, placed over a cylindrical vessel communicating with an air-pump, the air being exhausted, is bent by the pressure ; a bladder, substituted for the hand will burst with a loud report.

2. *Cupping.*—Air exhausted, flesh rises ; blood flows from wounds previously made with lancets.

3. *Suction*. — Water raised in a tube, air drawn or pumped out, water beneath, relieved of the pressure, rises.

4. Toys called *suckers* adhere to the various substances against which they are placed by pressure of the atmosphere.

5. Insects walk on smooth panes of glass and on ceilings of rooms, with their bodies suspended; how? their feet supplied with apparatus for excluding the air between them and the surface; the pressure of the air supports them against the force of gravitation. By the same means the walrus climbs icy rocks, the lizard ascends walls, and shell-fish adhere to rocks.

6. Vent-holes required in vessels before liquids will run; why? they admit the air; what effect is produced? A common and familiar example of this is seen in the teapot lid.

Uses.

a. This pressure is essential to our comfort and life; preserves the tone and vigour of our bodies; when partially removed (as in the *rarefied* air of elevated regions) the smaller blood-vessels of the body will occasionally burst, and blood flow from the ears and nose.

b. Prevents the fluids of the earth being wholly converted into vapour by the heat of the sun.

c. Raises water to the height of thirty-three feet; supports mercury at from twenty-eight to thirty-one inches; the latter is thirteen and a half times heavier than water, — therefore a column of water thirty-three feet high equals one of mercury of thirty inches.

Note. — “The atmosphere rises above us with its cathedral dome arching towards the heaven

of which it is the most familiar symbol. It floats around us like that grand object which the Apostle St. John saw in his vision — ‘a sea of glass like unto crystal.’ So massive is it, that when it begins to stir, it tosses about great ships like playthings, and sweeps cities and forests like snowflakes to destruction before it. Its weight is so enormous that iron shivers before it like glass; yet a soap-bell sails through it with impunity, and the tiniest insect waves it with its wings. It ministers lavishly to all our senses. We touch it not, but it touches us; its warm south wind brings back colour to the pale face of the invalid; its cool west winds refresh the fevered brow and make the blood mantle in our cheeks; even its north blasts brace into new vigour the hardened children of our rugged clime. But for it the rainbow would want its triumphal arch, and the winds would not send their fleecy messengers on errands round the heavens; the cold ether would not shed its snow feathers on the earth, nor would drops of dew gather on the flowers; the kindly rain would never fall, hail-storm nor fog diversify the face of the sky; our naked globe would turn its tanned, unshadowed forehead to the sun, and one dreary monotonous blaze of light and heat dazzle and burn up all things.”

LESSON LVI.—RIVERS.

I. Origin of Rivers.

NOTICE that water is constantly moving from the earth to the sky and from the sky to the earth;

minute watery particles drawn up by evaporation ; *pure* water only raised ; the process imperceptible ; this vapour, condensed by contact with cooler substances (cold air, rocks, sides and tops of mountains), descends as rain, snow, and hail. Rain absorbed by the porous earth (compare with a wet sponge) ; sinks till it reaches an impervious stratum of rocks and earth ; the source of springs. Small *rills* descend, —

“ A new-born rill,
Just trickling from its mossy bed,
Streaking the heath-clad hill
With a bright emerald thread ;”

these, uniting, form a small stream, a *rivulet*—gradually enlarged to a *river*. Commencement called the *source*. This is generally either a *spring*, —

“ The crystal treasures of the liquid world,
Through the stirr'd sands a bubbling passage burst,
And, welling out, around the middle steep,
Or from the bottoms of the bosom'd hills,
In pure effusion flow ;”

the *snows and glaciers* of mountainous districts,—

“ By a thousand pretty rills
That tumble down the snowy hills ;”

or *overflowing lakes*. The primary stream is increased by the waters of *tributaries* or *affluents* ; their junction is called the *confluence* — *e. g.*, *Ken-*
net and *Thames*, *Wye* and *Severn*.

II. *Course and Basin.*

The direction of rivers is determined by the nature of the country between the source and termination ; some nearly straight, others extremely circuitous ; winding courses caused by their journeys round hills

— *e. g.*, Meander (Asia Minor), Wye, &c. (notice the derivation of *meandering*). Streams beginning in mountains have rapid currents. *Length* determined by the proximity of the source to the sea; hence short rivers on the *western* sides of Norway, Wales, and South America, and longer of South-Eastern Europe. A line enclosing the country drained by the primary and affluent streams will mark the boundary of the river's *basin*; this varies in extent; includes the whole region whence the waters of the river are obtained. Compare the basins of a few; *e. g.*:—

Amazon	-	-	-	1,920,000	square miles.
La Plata	-	-	-	1,560,000	" "
Nile	-	-	-	797,000	" "
Volga	-	-	-	653,000	" "
Thames	-	-	-	5,000	" "

Beds of rivers generally surcharged in tropical countries *periodically*; surrounding districts inundated — *e. g.*, Nile, Jordan, Ganges, Tigris, &c. The Nile rises in the middle of June, and by August the whole valley is covered. The Ganges submerges the adjoining districts under twelve feet, and in places even thirty feet, of water. The Obi and Lena overflow; why? mouths blocked with ice, no egress for the water.

III. *The Mouth.*

Primary rivers generally run towards and enter seas—*oceanic*; others, *continental*, disappear in the sands of deserts or flow into lakes—*e. g.*, Oxus, Volga, Jordan, &c. Some discharge their waters by a single mouth, others by several—forming *deltas*; among the former, St. Lawrence and La Plata, —

“The sea-like Plata, to whose dread expanse,
Continuous depth, and wondrous length of course,
Our floods are rills,”—

and the latter, Nile, Volga, Ganges, Rhone, Rhine, &c.

IV. *Uses.*

Draw from the children the uses of rivers ; as, for —

1. *Drainage.* — Removing waters which would otherwise render large districts useless.

2. *Navigation.* — Commercial communication ; convey wealth abroad and receive riches in return ; hence the sides of *navigable* rivers become the sites of cities and towns.

3. *Irrigation.* — The banks verdant and fertile ; the fertility of the soil is frequently the gift of the river.

4. Supply *natural boundaries* to states, &c.

5. A *motive power* for various manufacturing processes.

6. Their fish supply food, and the plants they nourish are endless.

Notice them also as emblems of man's life: —

“ See the rivers, how they run
Through woods and meads, through shade and sun,
Sometimes swift, and sometimes slow,
Wave succeeding wave, they go :
A various journey to the deep,
Like human life to its long sleep !
Thus is nature's vesture wrought,
To instruct our wandering thought ;
Thus she dresses green and gay,
To disperse our cares away.”

LESSON LVII. — SNOW.

I. *Formation.*

RELATE the account of a fall of snow which occurred in a *ball-room* at St. Petersburg : a window being broken in a very crowded room, a shower of snow immediately followed. Elicit from the children the cause : the warm air of the room contained much vapour, which was *condensed* and *frozen* by the cold air admitted through the broken glass, and fell in minute flakes. Apply this *generally* : cold and warm air meet; the moisture of the latter is condensed, frozen, and precipitated to the earth in the form of snow ; generally occurs in winter, when no heat is radiated from the earth ; the atmosphere is therefore cold, and the vapour more readily condensed and frozen into snow—earth's "winter robe of purest white." Falls occasionally in summer ; has been seen in the south of England as late as June. Flakes composed of crystals formed into beautiful and varied shapes, chiefly stelliform and hexagonal, particularly in the polar regions ; in our own and warmer countries they are deformed in their descent by contact with each other, and assume irregular shapes. "Snow of the most regular and beautiful crystals fell gently on our clothes (*i. e.*, at St. Petersburg) ; all of them possessed exactly the same figure, consisting of a wheel or star with six equal rays." On the Alps it resembles fine sand. In colour chiefly white—hence, "white as snow ;" sometimes found red or green ; these colours are probably caused by the presence of minute animal or vegetable forms.

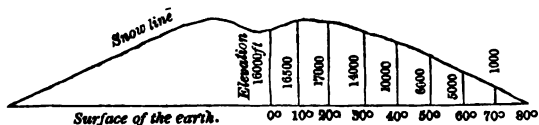
"Through the hush'd air the whitening shower descends,
At first thin wavering ; till at last the flakes
Fall broad, and wide, and fast, dimming the day
With a continual flow."

II. The Snow Line.

At a great elevation in tropical countries the snow becomes *perpetual*; the same occurs on the level ground at eighty degrees latitude. The *limit* therefore varies; generally increases in height as we approach the *equator*, where it is *sixteen thousand* feet; but at latitude ten degrees it is five hundred feet higher (16,500 feet), at twenty degrees five hundred feet more (17,000 feet). Why is this? the days at the equator are of *uniform length*, twelve hours; at the tropics they are at the longest thirteen and a half; the summer heat is therefore greater there, and consequently the elevation is increased. The snow-capped mountains of many countries are most beautiful: —

“Some blue peaks in the distance rose,
And, white against the white cold sky,
Shone out their crowning snows.”

The following diagram may be drawn on a black-board to illustrate this.*



III. Snow Storms.

These are occasionally very severe; many have proved fatal to travellers. Scotland and America often visited by them. On the Alps dogs render great assistance in saving travellers in these storms. Give an account of a few.

a. In 1620 the snow fell for nearly a fortnight,

* From the *Gallery of Nature*.

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with little intermission ; known as the "thirteen drift days;" about twenty thousand sheep perished on the Eskdale Moor, Scotland.

b. Again, in 1794, seventeen shepherds and nearly two thousand sheep perished in Scotland.

c. In 1799, Elizabeth Woodcock, returning home from Cambridge market, was buried in a drift from Feb. 2nd to 10th.

d. 1853 and 1854, severe storms. In the former three soldiers were lost on Dartmoor, when travelling from Plymouth ; the latter greatly impeded the traffic by railways, the snow drifting into the cuttings and tunnels ; it also increased materially the great sufferings of our army in the Crimea.

IV.* *Travelling over Snow.*

In some countries snow affords an easy means of communication. The contrivances to assist such travelling are principally, (1) sledges, (2) snow-shoes, and (3) snow-skates.

1. *Sledges.* — These are common in all northern countries ; drawn either by dogs, reindeer, or horses. The dogs used for this purpose are very valuable—as much as fifty pounds has been given for three small ones.

2. *Snow-shoes.* — Used by the Canadians and North American Indians ; made of two light bars of wood turned up in front ; fixed by cross pieces and netted together ; about two pounds in weight each ; from four to six feet long—eighteen to twenty-one inches wide, according to the size of the foot of the wearer. Strapped on.

3. *Snow-skates or skies.* — Composed of two thin pieces of fir of unequal length—for the left

* The first three divisions will be sufficient for a single lesson.

foot *seven* feet long, for the right only five ; three inches wide ; curved up in front ; covered with seal and bearskin ; attached to the foot by leather thongs. Used in Norway by men and women, who thus cross mountains, rivers, and lakes, and can outstrip a horse and sledge on the level ground.

Travellers in these regions are often afflicted by *snow-blindness* ; the dazzling glare of the sun produces a most distressing effect. A small pimple forms on the eye-ball ; the least light causes intense pain. A poultice of snow relieves it. The Esquimaux, to escape it, wear wooden shades over their eyes. It generally happens when the sun makes —

“ The dazzling snow more dazzling fair.”

V. *Uses.*

“ He giveth snow like wool ;” where is the resemblance ? both are white and warm ; each a bad conductor of heat ; snow prevents radiation. Hence :—

a. It affords protection to vegetation in winter ; shelters the plants from the cold frost and bitter winds, —

“ Earth receives

Gladly, the thickening mantle ; and the green
And tender blade, that fear'd the chilling blast,
Escapes unhurt beneath so warm a veil,”—

e. g., delicate plants are found growing among the snows of the Alps which will not grow in England ; persons buried in the snow for days have been rescued alive.

b. Supplies moisture and nourishment ; conveys gases into the soil, which penetrate and fertilise it.

c. When perpetual on lofty mountains, is the source of large rivers.

d. A suitable shelter in cold regions. The seal hunters erect walls of snow, under which they watch their prey. Of it the Esquimaux build their huts, so admirably adapted to their wants — protecting them from the external cold, and preventing the dispersion of the internal heat; “the walls, being only three or four inches thick, are sufficiently translucent to admit an agreeable light; or a window is cut, and the aperture fitted with a piece of clear ice. The seats, tables, and sleeping-places are of snow, and a covering of skin renders them comfortable to the inmates.”

Notice how it is intimately connected in our minds with “merry Christmas,”—this vesture of purity being singularly appropriate to the season of the Holy Nativity, when—

“Nature, in awe of Him, hath doff’d her gaudy trim,
With her great Maker so to sympathise:
To hide her guilty front with innocent snow,
And on her naked shame, pollute with sinful blame,
The saintly veil of maiden white to throw;
Confounded that her Maker’s eyes
Should look so close upon her foul deformities.”—MILTON.

VI. *Lessons.*

Elicit from the children:—

(1) That it leads us to admire God’s wonderful and beneficent works for the good of His creatures,—for, “Whoso is wise will ponder these things; and they shall understand the loving-kindness of the Lord;” and—

(2) That it reminds us of the “white robe” which, as His children, we are to strive to keep unspotted, and in which we are to appear at the end, if found faithful. (*Vide* Rev. vii. 13, 14.)

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